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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management ond Budget through September 30, 1985.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey, MS 421
Reston, VA 22092

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Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

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Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1A. Properties

THERMAL DEPENDENT PHYSICAL PROPERTIES OF WATER,
New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
R. J. Heggen.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 298-302, February, 1983. 2 Tab, 4 Ref.

Descriptors: *Water, *Physical properties, *Temperature effects, Viscosity, Fluid mechanics, Mathematical equations, Hydraulic engineering, Specific heat, Density, Surface tension, Vapor pressure.

A set of empirical equations is presented for six fundamental properties of water: dynamic viscosity; mass density; isobaric specific heat; isothermal compressibility; surface tension; and vapor pressure. These six properties are commonly taken as fundamental properties in engineering fluid mechanics. The equations represent an analytic middle ground, less lengthy than their counterparts in the physical literature, but describing thermal dependence with precision equaling or exceeding the accuracy associated with most engineering calculations. The constants and functions given provide useful estimators for these properties. These estimators model the properties' sensitivity to temperature over a broad thermal range. The accuracy of estimation is adequate for most hydraulic engineering calculations. Many other physical properties can be expressed as functions of the six investigated, though the option remains to be added to this fundamental list. (Baker-IVI)
W84-04833

HIGH FREQUENCY EXCITATION AND VIBRATION STUDIES ON HYPERFILTRATION MEMBRANES,
California Univ., Berkeley. Water Thermal and Chemical Technology Center.
C. C. Herrmann.
Desalination, Vol. 42, No. 3, p 329-338, September, 1982. 2 Fig, 1 Tab, 20 Ref.

Descriptors: *High frequency excitation, *High frequency vibration, *Hyperfiltration membranes, Water yield improvement, Reverse osmosis, Desalination, Desalination apparatus.

In an effort to increase the freshwater production rate, possible effects of high-frequency vibrations (both acoustically and electrically induced) on the hyperfiltration (reverse osmosis) process have been reexamined comprehensively. Cellulose-acetate membranes were used, both as customarily prepared by the Loeb-Sourirajan process, and with added magnetic and non-magnetic iron oxide powders. Flow and salt rejection were measured with sodium chloride feeds, without and with iron hydroxide or calcium sulfate membrane fouling. Flow rejection were substantially independent of the applied vibrations over the frequency and power ranges applied. The one exception was ultrasonic vibration on a depressurized, foul membrane, which showed an advantageous cleaning effect (hyperfiltrate flux increased after the treatment), confirming previous observations. (Author's abstract)
W84-04939

EXCHANGE PROCESSES AT THE SURFACE OF WATER (AUSTAUSCHVORGANGE AN DER OBERFLACHE VON GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydrologie und Wasserwirtschaft.
For primary bibliographic entry see Field 2K.
W84-05259

STUDY OF WATER,
University Coll., Dublin (Ireland). School of Engineering.
For primary bibliographic entry see Field 2A.
W84-05296

2. WATER CYCLE

2A. General

ADAPTIVE PARAMETER ESTIMATION FOR NON-LINEAR HYDROLOGICAL MODELS WITH GENERAL LOSS FUNCTIONS,
Institute of Hydrology, Wallingford (England).
D. M. Cooper.
Journal of Hydrology, Vol. 58, No. 1-2, p 39-45, August, 1982. 4 Fig, 5 Tab, 25 Ref.

Descriptors: *Hydrologic models, *Mathematical equations, Estimating, Algorithms, Non-linear models, Recursive procedures.

A simple algorithm for sequentially estimating the parameters of non-linear hydrological models is presented. The method used is related to the Kiefer-Wolfowitz stochastic approximation algorithm. The examples demonstrate that it is possible to find sequential procedures which can be used to estimate the parameters of quite general models, subject to certain constraints on the derivatives of the loss structure used and the choice of parameterization and starting values. In practice the procedures may be rather sensitive when these constraints are not satisfied. Even in such cases, the recursively computed estimates and the derivatives of the loss function can demonstrate where model inadequacy occurs, and how important particular parameters are. (Baker-IVI)
W84-04837

DISCRETIZATION OF THE CONTINUOUS LINEAR CASCADE BY MEANS OF STATE SPACE ANALYSIS,
Lulea Univ. (Sweden). Div. of Water Resources Engineering.
A. Szollosi-Nagy.
Journal of Hydrology, Vol. 58, No. 3/4, p 223-236, September, 1982. 18 Ref.

Descriptors: *Performance evaluation, *Continuous linear cascade models, *State space analysis, Hydrological forecasting, Nash cascade, State space modeling, State transition matrix, Model studies, Hydrologic aspects, Hydrologic data, Hydrologic models, Forecasting, Mathematical models, Mathematical equations.

Following the principles of state space analysis an attempt was made to derive a theoretically verified discretization of the continuous Nash cascade. In applying digital filtering techniques for hydrological forecasting by means of cascade models a discrete model of the continuous processes involved is necessary. The paper deals with the discretization of the continuous Nash cascade. The principles of state space modelling are used. The continuous state variable model of the Nash cascade together with the computation of the state transition matrix and the impulse response is given. A discrete state variable model is derived whose state and input transition matrices are in a dual relationship. Any different discrete state representations of the continuous Nash cascade are related to each other via a linear transformation. In the limit case the discrete state models are identical with the continuous Nash cascade. The discrete state models are discretely coincident with the continuous model but at the same time consider the dynamic changes in between the sampling points. A numerical example is presented. (Murphy-IVI)
W84-04848

HYDROLOGICAL CONDITIONS AND MEASURES OF WATER PROTECTION IN ENGADINE (HYDROLOGISCHE VERHALTNISSE UND GEWASSERSCHUTZMASSNAHMEN IM ENGADIN),
Amt fuer Gewasserschutz Graubunden, Chur (Switzerland).
R. Gartmann.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 172-180, 1982. 3 Tab.

Descriptors: *Drainage area, *Hydrologic aspects, *Hydrology, *Engadine, Flaz River, Spol River, Schergenbach River, Inn River, Water pollution control, Switzerland.

The drainage area of the Inn with its main affluents, namely Flaz, Spol and Schergenbach until Martinsbruck covers a total area of 1945 sq km; it is situated at an average altitude of 2350 m over the sea and a glacier covers about 5.4% of its surface. The Engadine and its side values have a population of somewhat more than 21,500 permanent inhabitants. Its main industries are tourism with more than 47,000 beds or 3.1 million booked nights per year and the production of about 1 billion kWh/p.a. of hydroelectric energy which corresponds to high peaks of drinking water, sewage and wastes resulting from the reduced run-off of the rivers because of the production of energy, as well as from special infrastructure problems of the communities. Owing to the waste water treatment plants already built, more than 80% of the sewage of the permanent population and of the tourists can be treated as required by the law and the total production of wastes can be treated without damage to the environment. (Author's abstract)
W84-04906

REGIONAL MONTHLY RAINFALL-RUNOFF MODEL,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
M. Mimikou, and A. R. Rao.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 75-93, January, 1983. 17 Fig, 6 Tab, 8 Ref.

Descriptors: *Rainfall-runoff relationships, *Model studies, Flow, Nonlinear programming, Basins, River basins.

A simple regional model for basins with either linear or nonlinear monthly rainfall-runoff behavior is presented. The structure of the model depends on two key parameters: an order parameter and a memory parameter, which control the runoff behavior of the basin and the memory of the rainfall-runoff process, respectively. The order parameter, k, is a basin characteristic, whereas the memory parameter, n, is a characteristic of month, equal to k for months with delayed runoff and zero otherwise. For basins with linear monthly rainfall-runoff behavior, k is equal to one. For basins with nonlinear monthly rainfall-runoff behavior, k is greater than one and is equal to the approximate order of nonlinearity of the monthly rainfall-runoff functional relations. Good relationships exist between the coefficients of the model and the monthly runoff coefficients of the basin, and between the latter and the rainfall reduced to the unit area of the basin. Under such circumstances the model is regionalized and may thus be used in other ungaged basins of the same region. The model preserves the historical monthly means and standard deviations of flow at the 90% confidence level. (Baker-IVI)
W84-04957

DERIVATION OF DISCRETELY COINCIDENT FORMS OF CONTINUOUS LINEAR TIME-INVARIANT MODELS USING THE TRANSFER FUNCTION APPROACH,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
K. M. O'Connor.
Journal of Hydrology, Vol. 59, No. 1-2, p 1-48, October, 1982. 2 Fig, 1 Tab, 37 Ref.

Descriptors: *Model studies, *Hydrologic models, Flood routing, Stochastic hydrology, Mathematical models, Parametric hydrology.

A general transfer function (transform) method for deriving the discretely coincident forms (difference equations) of continuous linear parametric models (differential equations) is presented. Examples of the method, for zero-order (pulsed) and first-order (linear) input functions between the sampling intervals are given. The examples chosen are some of the classic continuous parametric models of linear deterministic hydrology. The method is capable of being extended to higher-order polynomial input

types. A comparison is made between the different forms of linear difference equations, commonly used in hydrology, namely: those based on finite-difference approximations to the classic continuous parametric models; discretely coincident forms of the classic continuous models; and discrete analogies of the classic continuous parametric models. (Baker-IVI)
W84-05126

DYESTUFF PENETRATION IN SOILS AT VEGETATION BOUNDARIES: THE EFFECT OF THE CANOPY,
Lancaster Univ., Bailrigg (England). Dept. of Geography.
P. J. Vincent, and J. V. Clarke.
Journal of Hydrology, Vol. 59, No. 1-2, p 149-160, October, 1982. 3 Fig, 2 Tab, 14 Ref.

Descriptors: *Interception, *Canopy, *Soil water, *Dye releases, Tracers, Vegetation, Soil surface, Precipitation, Alder, Oak, Pine, Spruce, Root channels, Seasonal variation.

Vegetation cover not only reduces the amount of rainfall that reaches the soil surface but also redistributes the intercepted rainfall, according to the type of vegetation present. On reaching the soil surface the downward movement of water is not uniform as it is dependent on a variety of factors such as hydraulic gradients and local porosity conditions. Water-insoluble 'disperse' dyestuff were used to investigate the penetration of precipitation into soil under various vegetation canopy conditions. Water-insoluble dyestuffs have advantageous properties; they are unlikely to be washed completely out of the soil after long periods, they are not biodegradable and are not attracted to the clay-humus complex. Experiments were carried out during a three-month spring and three-month autumn period at the Gisburn Forest, Yorkshire, England. Under open-canopy conditions, dyestuff penetration under a grass-health canopy and under deciduous alder and oak canopies was similar. Dyestuff penetration was reduced under the latter two canopies after leaf development. Dyestuff penetration under Scots pine and Sitka spruce during the same experimental periods did not show the same strong seasonal variation. Root channels may allow very effective movement of soil water. (Moore-IVI)
W84-05132

RAINFALL AND RECHARGE TO A DOLOMITE AQUIFER IN A SEMI-ARID CLIMATE AT KABWE, ZAMBIA,
Aspinwall Hydrotechnical Services Ltd., Shrewsbury (England).
J. F. T. Houston.
Journal of Hydrology, Vol. 59, No. 1-2, p 173-187, October, 1982. 10 Fig, 3 Tab, 12 Ref.

Descriptors: *Groundwater recharge, *Rainfall, *Zambia, *Kabwe, Dolomite aquifers, Semiarid climates, Natural recharge, Recharge, Evapotranspiration, Forests.

The mean annual rainfall is 937 mm and over long periods of time appears to be relatively stable. Short-period fluctuations are marked and have considerable effect on recharge. Wet years tend to be more intense and of shorter persistence than dry years which by contrast tend to be less intense, less frequent and last slightly longer. The change from wet to dry years tends to show a cyclicity based upon periods of 8 and 4 years. The highest rainfall during the year occurs from December to March and at the same time evapotranspiration is relatively low. Thus recharge to groundwater storage can be expected to take place only during these months and this is confirmed by borehole hydrographs. The proposed recharge model differs slightly from the conventional methods and gives realistic results under semi-arid conditions, provided attention is paid to the natural vegetation cover and consequent estimates of evapotranspiration and selection of appropriate root constant. Precipitation recharge occurs every year over most of the outcrop and is estimated to be 281 mm on a mean annual basis but varies considerably with the annual rainfall. Under open-forest, recharge is restricted to high-rainfall years and the following year when soil-moisture deficits are still relatively low. Mean annual recharge under open forest is estimated to be 80 mm. (Baker-IVI)
W84-05134

TWO-D FLOW WITH SEDIMENT BY CHARACTERISTICS METHOD,
Colorado State Univ., Fort Collins.
P.-N. Lin, and H.-W. Shen.
Journal of Hydraulic Engineering, Vol. 110, No. 5, p 615-626, May, 1984. 3 Fig, 1 Tab, 9 Ref. NSF grant ENG7825054.

Descriptors: *Unsteady flow, *Mathematical equations, *Sediment transport, Suspended sediments, Sediment diffusion.

The theory of characteristics is applied to analyze two-dimensional unsteady flow over a bed of fine sediment. The case under consideration is that of flow over a bed of material which is so fine that suspension is the predominant mode of sediment transport, such as flow in some estuaries and in rivers carrying heavy loads of fine sediment. An additional equation for sediment diffusion is introduced so that five equations are available for five unknowns and characteristics are explicitly defined without resorting to complicated algebraic equations. An analysis by the theory of characteristics is desirable because it provides a means to determine the correct boundary conditions required in order to make the problems well posed. Results from a one-dimensional version of this procedure agreed reasonably well with known data. (Moore-IVI)
W84-05148

PRELIMINARY QUANTIFICATION OF THE IMPACTS OF ASPEN TO CONIFER SUCCESSION ON WATER YIELD - II. MODELING RESULTS,
Utah State Univ., Logan. Coll. of Natural Resources.
G. F. Gifford, W. Humphries, and R. A. Jaynes.
Water Resources Bulletin, Vol. 20, No. 2, p 181-186, April, 1984. 6 Fig, 1 Tab, 3 Ref. OWRT project B-175-Utah, OWRT grant 14-34-0002-9138.

Descriptors: *Water yield, *Succession, *Consumptive use, Aspen, Fir, Spruce, Model studies, Streamflow, Hydrologic models, Transpiration.

Due to lack of widespread disturbances by such things as natural fires and clearcutting, many areas once dominated by aspen have become coniferous forests. A hydrologic model of aspen to conifer succession has been modified to reflect data acquired from a part I of this study, concerning plant activity patterns and community crop coefficients for spruce, aspen, and fir forests. The model describing the hydrology of aspen to conifer succession (ASPCON) consists of a series of moisture storage compartments connected by transfer equations that systematically deal with each set of input data. Applying the new coefficients to describe the timing and rates of transpiration, the model predicts 18.6 cm net loss of moisture available for streamflow when spruce replace aspen, and a loss of 7.2 cm when fir forests replace aspen. The aspen to conifer successional trend appears, therefore, to be significantly reducing water yields in the western United States. (Moore-IVI)
W84-05156

STATUS OF RIPARIAN ECOSYSTEMS IN THE UNITED STATES,
New York State Dept. of Environmental Conservation, Delmar. Div. of Fish and Wildlife.
B. L. Swift.
Water Resources Bulletin, Vol. 20, No. 2, p 223-228, April, 1984. 3 Tab, 40 Ref.

Descriptors: *Ecosystems, *Riparian vegetation, Woody plants, Land use, Environmental effects, Water resources development, Urbanization, Floodplains.

An attempt was made to review all available data on the extent and status of riparian ecosystems in the U.S.A. This report presents a synthesis of the findings, including some estimates of how much land was originally covered by woody riparian vegetation, and how much remains in that condition today. A synopsis of information is presented on the status of riparian ecosystems in each of 10 regions: California, Pacific Northwest, Rocky Mountains, Arid Southwest, Plains-Grasslands, Lake States, Corn Belt, Mississippi Delta, Northeast-Appalachian, and Southeast. Woody riparian plant communities once covered an estimated 75 to 100 million acres of land in the contiguous 48 states. Mankind has converted at least two-thirds of that nationwide acreage to other non-forest land uses and it is estimated that only 25 to 35 million acres of riparian plant communities remain in a near natural condition. Across the country, loss of riparian acreages is directly attributable to water resource development (especially channel modification and water impoundment), floodplain clearing for agriculture, and urbanization. In many states of the arid west, the midwest, and the lower Mississippi alluvial valley, riparian vegetation has been reduced in area by more than 80 percent. Riparian woodlands are one of this country's most heavily modified natural vegetation types. (Author's abstract)
W84-05162

SEEPAGE FROM SURFACE WATERS (STROMUNGSVORGANGE IN NATURLICHEN SICKERKORPERN IN DER NAHE VON OBERFLACHENGEWASSERN),
Karlsruhe Univ. (Germany, F.R.).
V. Kaleris.
Wasserwirtschaft, Vol. 73, No. 11, p 464-468, November, 1983. 5 Fig, 1 Tab, 8 Ref.

Descriptors: *Infiltration, *Surface flow, Infiltration rate, Infiltration coefficient, Infiltration capacity, Hydrologic models, Performance evaluation.

There are apparent uncertainties in determining the infiltration rate of small streams by numerical models. These uncertainties are emphasized with decreasing infiltration rates. The higher the infiltration rate the less effects these uncertainties have on the models' outcome. With improved procedures and more accurate measurements the models' outcome could average out the effects of the uncertainties. The results are compared with those of direct measurements of the infiltration rate. (Murphy-IVI)
W84-05264

SENSITIVITY OF WATER RESOURCE SYSTEMS TO CLIMATE VARIATION,
World Meteorological Organization, Geneva (Switzerland).
J. Nemec, and J. Schaake.
Hydrological Sciences Journal, Vol. 27, No. 3, p 327-343, September, 1982. 9 Fig, 1 Tab, 20 Ref.

Descriptors: *Climatology, *Water resources, *Planning, Rainfall-runoff relationships, Streamflow, Hydrologic models, Climates, Arid climates, Humid climates, Climatic data.

One of the single most serious technical problems facing water resource managers is that of determining the appropriate response to climate change. Climate statistics are inherent in the design of water resource systems by the prediction of two aspects of hydrological processes. This includes the extremes and the averages. The importance of the sensitivity of the systems to such variations is demonstrated with respect to the stationarity of the mean and the extremes. A definition of moderate climate variation is adopted. Results of deterministic modelling of the influence of such a variation on streamflow are reported, in extreme conditions of arid and humid basins. The results are used in modelling the influence of climate variations on reservoir storage systems. The model indicates a considerable amplification of the effect of climate change on runoff and storage and emphasizes the importance of studies of sensitivity of water resource systems to climate variation. (Murphy-IVI)
W84-05290

STUDY OF WATER,
University Coll., Dublin (Ireland). School of Engineering.
J. C. I. Dooge.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 23-48, 1983. 3 Fig, 3 Tab, 53 Ref.

Descriptors: *Hydrology, *Reviews, *Physical properties, Fluid mechanics, Social aspects, Mathematical equations, Newtonian fluid, Molecular structure.

A number of questions relative to the background of hydrology are discussed. Specific consideration is given to the meaning of the term water in a scientific context, the purpose of water on the planet, the reason why most of the water here is found in liquid form, the physical properties of water, the molecular structure of liquid water, treatment of liquid water as a continuum, the possibility of water being a Newtonian fluid, the movement of a Newtonian fluid, equations of water movement commonly used in hydrology, possible usefulness of the Navier-Stokes equations in hydrology, and the reconciliation of the various approaches to the study of water movement to each other, including the view of water by the scientist, the biologist and the social scientist. (Baker-IVI)
W84-05296

ANTECEDENT MOISTURE CONDITION PROBABILITIES FOR SELECTED INDIANA STATIONS,
Purdue Univ., Lafayette, IN. School of Civil Engineering.
C. R. Burke, and D. D. Gray.
Proceedings of the Indiana Academy of Sciences, Vol. 92, p 219-226, 1982. 2 Fig, 2 Tab, 18 Ref.

Descriptors: *Probability distribution, *Moisture, *Weather forecasting, Indiana, Mathematical equations, Predicting.

The analysis of 258 years of daily weather observations at 10 Indiana stations has been used to provide reliable estimates of the probability of occurrence of the Antecedent Moisture Condition classes of the Soil Conservation Service Curve Number method and the Illinois Urban Drainage Area Simulator (ILLUDAS) computer program. The uniformity of the probabilities across the state means that probabilities for any location in Indiana can be interpolated with confidence. The present results confirm and supercede the less statistically significant Antecedent Moisture Condition (AMC) probabilities published previously for fewer Indiana stations. (Baker-IVI)
W84-05308

EFFECT OF RAINDROP IMPACT AND SLOPE LENGTH ON SEDIMENT CONCENTRATION OF RUNOFF,
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
For primary bibliographic entry see Field 2J.
W84-05311

FINITE-ELEMENT THREE-DIMENSIONAL GROUNDWATER (FE3DGW) MODEL FOR A MULTIAQUIFER SYSTEM,
Battelle Project Management Div., Columbus, OH.
S. K. Gupta, R. C. Cole, and G. F. Pinder.
Water Resources Research, Vol. 20, No. 5, p 553-563, May, 1984. 14 Fig, 13 Ref. DOE Y-76-C-06-1830, EPA grant P002103-01-0, DOE DE-AC02-83CH10140.

Descriptors: *Aquifer characteristics, *Hydrologic models, Finite element method, Mathematical studies, Model studies, Groundwater, Computers, Aquifers.

Using a three-dimensional, isoparametric, finite-element scheme, a computer model (FE3DGW) is developed to simulate the steady state and transient behavior of large, natural, multilayered groundwater systems. A hydrologic basis for developing a finite-element grid is presented. Graphical displays generated by the supportive programs of the model and used to verify the input data of large, natural groundwater systems and to facilitate the interaction between modeler and field hydrogeologist are also given. Core storage was reduced by the three following methods. Small, independent subprograms were used, and only the parameter required by the subprogram was brought in core. Core storage was provided for one element only. The rest were stored on disk for sequential retrieval. In simulation of large, natural aquifer systems, unbanded sparse matrices of equations occur, requiring high core storage. Two matrices, one for storing only nonzero coefficients and one for the column identification of these nonzero coefficients were used. Ways in which the cost of three-dimensional computation was reduced are discussed. Model applications are illustrated with the simulation of a groundwater reservoir beneath Long Island, New York. The finite-element solutions are compared with electric analog models of the same region. (Baker-IVI)
W84-05329

DAILY PRECIPITATION MODELING BY DISCRETE AUTOREGRESSIVE MOVING AVERAGE PROCESSES,
Ohio Univ., Athens. Dept. of Civil Engineering.
T. J. Chang, M. L. Kavvas, and J. W. Delleur.
Water Resources Research, Vol. 20, No. 5, p 565-580, May, 1984. 13 Fig, 4 Tab, 27 Ref. USDI grant OWRT-B-112-IND.

Descriptors: *Precipitation, *Model studies, DARMA, Markov process, Mathematical studies, Stochastic process, Indiana.

Various models from the discrete autoregressive moving average (DARMA) family are constructed for and applied to the daily precipitation data in Indiana to account for the statistical dependence among the daily precipitation magnitudes and among the daily precipitation occurrence times. The structure of the DARMA family is specified by the marginal distribution of independent identically distributed (i.i.d.) discrete random variables and by their random linear combination. The fact that the correlation structure of the DARMA family can be specified independently of its marginal density is one fundamental property of the family. The DARMA correlation structure remains invariant under transformation of the marginal density. The Indiana daily precipitation data satisfied this property and facilitated their modeling by the DARMA family of processes. The Markov chain is a specified model with DARMA family. By discretizing the daily precipitation amount into a number of magnitude states the Indiana daily precipitation data was transformed into a multistate discrete precipitation sequence. The stochastic process of the daily precipitation sequences is analyzed in terms of the locally stationary seasons defined within the paper. In each season the candidate DARMA models are identified in terms of the covariance function within the season. The parameter estimation of these candidate models is done by fitting their theoretical autocorrelation functions to their empirical counterparts, and the state probabilities are obtained through the multistate mean run lengths. The theoretical run length distributions of the candidate models are derived for each of the precipitation magnitude states, including the dry state. The goodness-of-fit tests of the candidate models and the best model selection are based on the theoretical multistate run length distribution of the daily precipitation data. (Baker-IVI)
W84-05330

QUANTITATIVE ANALYSIS OF EXISTING CONDITIONS AND PRODUCTION STRATEGIES FOR THE BACA GEOTHERMAL SYSTEM, NEW MEXICO,
Geotrans, Inc., Herndon, VA.
W. P. Balleau.
Water Resources Research, Vol. 20, No. 5, p 601-618, May, 1984. 15 Fig, 6 Tab, 37 Ref. Bureau of Indian Affairs contract MOOC14203411.

Descriptors: *Geothermal studies, *Model studies, Jemez River, Jemez Spring, Baca, New Mexico, Jemez Mountains, Fluid mechanics, Flow, Finite difference methods.

This modeling study is an attempt to bring together existing information and data on the Baca location and to develop a rational framework on how the system operates. The framework is a numerical model that incorporates a conceptual description of the physics of fluid flow and heat transport in an equivalent porous medium, the thermodynamics of two phase, single component water, a geometric description of the Baca field including boundary conditions, and the hydrologic and heat transport parameters that characterize the Baca field. The geothermal reservoir is recharged from a deep source having a small effective area. Vertical permeabilities are less than horizontal permeabilities in the geothermal reservoir. The calibrated preproduction thermal water discharge determined by numerical simulation is about 51,000 g/s (1310 acre feet/year), with about 88% of that discharge occurring at or above the Jemez Springs area. The contribution to base flow in the Jemez River is primarily from shallow groundwater aquifers. The total base flow along the Jemez River estimated for preproduction conditions is about 539,000 g/s (13,800 acre feet/year), which is about 10 times larger than the thermal water contribution. For a 30-year production period the following changes in reservoir conditions are estimated: a maximum reservoir pressure decline of 750 psi will occur in the main production zone in the lower part of the reservoir, the maximum steam saturation within the reservoir in the main production area will be about 40%, and maximum temperature declines in the production zone will be less than 3 degrees C. (Baker-IVI)
W84-05333

EFFECTS OF SPATIAL VARIABILITY OF HYDRAULIC RESISTANCE OF RUNOFF HYDROGRAPHS,
Colorado Agricultural Experiment Station, Fort Collins.
Y.-H. Wu, D. A. Woolhiser, and V. Yevjevich.
Journal of Hydrology, Vol. 59, No. 3-4, p 231-248, November, 1982. 10 Fig, 4 Tab, 9 Ref.

Descriptors: *Overland flow, *Runoff, Hydrographs, Roughness, Watersheds, Rainfall, Rainfall-runoff relationships, Spatial distribution.

The effects of spatial variability of roughness on runoff hydrographs have been investigated for an experimental watershed facility surfaced with butyl rubber or various combinations of butyl rubber covered with gravel. An equivalent uniform roughness (defined in terms of the hydrograph response to identical rainfall excess patterns) can be used for a watershed with nonuniform roughness over its surface, if the hydrographs from this watershed are equivalent to the hydrographs of a watershed of equivalent uniform roughness for identical rainfall excess patterns. The factors that affect the application of the equivalent uniform roughness concept are the differences between roughnesses, relative subarea of a given constant roughness, and the size of these uniform roughness subareas. For a watershed composed of alternate strips of equal widths of two roughness surfaces along the flow direction, apparently the watershed can be approximated by an equivalent uniform roughness surface, if the width of strips is less than or equal to one-sixth of the total flow length. The lumped parameters of the two-parameter model for a watershed of equivalent uniform roughness can be estimated by selecting those parameter values which reproduce the equilibrium detention storage on the nonuniform surface and are consistent with the values for the individual roughness elements. These conclusions are strictly valid only for overland flow on conical section watersheds, with two kinds of roughness elements. Only surface runoff response was considered. (Baker-IVI)
W84-05339

SPACE-TIME QUANTIFICATION OF RAINFALL INPUTS FOR HYDROLOGICAL TRANSPORT MODELS,
Agricultural Research Service, Chickasha, OK. Southern Great Plains Watershed Research Center.
A. D. Nicks.

Journal of Hydrology, Vol. 59, No. 3-4, p 249-260, November, 1982. 3 Fig, 4 Tab, 18 Ref.

Descriptors: *Hydrologic models, *Rainfall, Spatial distribution, Temporal distribution, Model studies, Transport.

Time and spatial rainfall input to hydrological models are discussed from the standpoint of available data sources, microscale and mesoscale networks and the type of models available. Using rainfall records from a dense network of recording raingages methods of distribution rainfall from point amounts to distributed runoff model area elements are tested. Density of the raingage network spacing vs. size of the distributive model elements are tested on basins ranging in size from 67 to 2926 sq km. Models should be developed that will account for time increment effects on runoff generation. One model tested showed an increase of 24% in predicted runoff when breakpoint rainfall was input instead of the original hourly input data. Spatial distribution of rainfall described by experimental watershed networks is probably adequate for most distributive type models. For the wide spaced climatological networks, the costs of using available distribution methods would be prohibitive for short time input with a small grid interval on a large area. More research is needed to set guidelines on the size of grid element vs. network gage density. (Baker-IVI)
W84-05340

GENERALISED ONE-DIMENSIONAL KINEMATIC CATCHMENT MODEL,
Newcastle Univ. (Australia). Dept. of Civil Engineering.
W. G. Field, and B. J. Williams.
Journal of Hydrology, Vol. 60, No. 1-4, p 25-42, January, 1983. 6 Fig, 1 Tab, 3 Ref.

Descriptors: *Kinematic wave theory, *Catchments, Mathematical studies, Model studies, Hydrologic models.

A numerical model has been developed for the solution of the kinematic wave equation for a one-dimensional catchment whose physical characteristics are continuously variable along the length of the mainstream, using the Lax-Wendroff technique. The model has been verified by comparing its solutions with some analytical solutions already available. Certain catchment parameters have been identified, some effects of storage non-linearity are noted, and the model is appplied with promising results to two actual catchments to ascertain their values. The two most restrictive limitations of the model are the one-dimensional assumption of uniform flow across the width of the catchment, and the assumption of spatially uniform rainfall over the catchment. (Baker-IVI)
W84-05347

2B. Precipitation

SPATIAL AND TEMPORAL RELATIONSHIPS BETWEEN THE INDIAN SUMMER MONSOON RAINFALL AND THE SOUTHERN OSCILLATION,
Indian Inst. of Tropical Meteorology, Poona.
B. Parthasarathy, and G. B. Pant.
Tellus, Vol. 36A, No. 3, p 269-277, May, 1984. 5 Fig, 2 Tab, 30 Ref.

Descriptors: *Spatial relationships, *Temporal relationships, *Indian summer monsoon, *Rainfall, *Southern oscillation, Tropical circulation, Monsoons, Air circulation, Air masses.

The Southern Oscillation is one of the important tropical circulation features having a profound influence on the Indian summer monsoon. A detailed investigation of the association between the Southern Oscillation Index (SOI) series of Wright and the Indian summer monsoon rainfall for a period of 104 years (1871-1974) has been carried out. The correlation analysis was carried out for two seasons (MAM and JJA) of SOI and June to September area-weighted rainfall series of India, its 29 subdivisions, and 306 individual representative stations. The series has been examined by dividing it into two equal halves of 52 years, and different sliding window width series of 10, 20 and 30 years. The correlations for the concurrent season (SOI-JJA) show a stable and highly significant relationship, whereas the correlations of the previous season (SOI-MAM) with summer monsoon rainfall are marginally significant for few areas of the country. The space and time relationships between the Southern Oscillation and Indian summer monsoon rainfall have potential applications for the understanding and prediction of the large-scale performance of the monsoon. (Author's abstract)
W84-04808

RADAR RAIN FORECASTING FOR WASTEWATER CONTROL,
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Agricultural Engineering.
C. Damant, G. L. Austin, A. Bellon, M. Osseyrane, and N. Nguyen.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 293-297, February, 1983. 16 Ref.

Descriptors: *Weather forecasting, *Rainfall, *Radar, *Combined wastewater, *Montreal, *Quebec, Forecasting, Flushing, Storms, Error analysis, Wastewater management.

A statistical analysis of the errors involved in forecasting rain amounts for the Island of Montreal using weather radar data has been undertaken. The wastewaters of all municipalities of the Communaute Urbaine de Montreal (CUM) at present discharged into the Riviere des Prairies, will be collected by a new north interceptor and conveyed to a treatment plant at the east end of the island. This interceptor was designed to collect all the flow from the sanitary sewers. However, it will only carry 2.5 times the mean dry weather flow from the combined sewage and stormwater drains. The amounts of rain accumulated in 1 hr over the CUM gages is measured by the low resolution radar data to an accuracy of 33%. Moreover, this same resolution data has been demonstrated to give forecast accumulation to an accuracy of within 68%, 89%, and 102%, for 1-, 2-, and 3-hr forecasts. It is thought that these errors could be significantly reduced if the new data were reanalyzed at higher resolution. It remains to be seen if forecasts of this accuracy are useful in giving a significant improvement in the operation of the CUM wastewater management system compared with the present situation of no or vague forecast information. (Baker-IVI)
W84-04832

PROBABLE RAINFALL ESTIMATES AND THE PROBLEMS OF OUTLIERS,
Iwate Univ., Morioka. Faculty of Agriculture.
N. Kishihara, and S. Gregory.
Journal of Hydrology, Vol. 58, No. 3/4, p 341-356, September, 1982. 7 Fig, 5 Tab, 14 Ref.

Descriptors: *Rainfall, *Forecasting, *Rainstorms, Prediction, Daily rainfall, Depth-area-duration analysis.

The occurrence of the unusual 'Exceptionally heavy' short period rainfall event is characteristic of virtually all areas of the world, and these occurences have important implications for floods and landslides, dam construction, river works, and soil- and water-conservation structures. The problem of estimating return periods of maximum daily rainfall when one or two extreme events are exceptionally large has been examined, but not resolved, by many writers. The present paper attempts to specify and clarify these conditions, preparatory to proposing solutions in a later paper. Earlier work on this problem in Japan, the U.S.A. and the U.K., is reviewed, and 90 stations in the U.K. are classified into several 'return period types' following the method proposed by Kikuchibara for Japan. The effectiveness with which the 100-yr. return period value can be estimated by a large number of standard methods is examined for each of these different 'types', and the inadequacy of all of them in relation to the exceptional extreme event is stressed. It is evident that stations often change from one of these 'types' to another, and that therefore the ability to estimate the 100-yr. return period value also changes markedly with time. (Murphy-IVI)
W84-04855

MOON INFLUENCES WESTERN U.S. DROUGHT,
R. A. Kerr.
Science, Vol. 224, No. 4649, p 587, 11 May, 1984. 1 Ref.

Descriptors: *Drought, *Tidal effects, *Lumar cycle, *Great plains, Tidal cycle, Climates, Tidal cycle, Moon, Tree rings.

Although it is a subtle effect, the lunar cycle that influences drought in the American Great Plains, in combination with a previously reported solar influence, may on rare occasions wreak such widespread havoc as the Dust Bowl of the 1930's. The narrowing of tree rings during drought conditions revealed a tendency over a 360 yr record toward an expansion of the area of drought about every 22 years. Further studies linked the tree rings theory more closely with the 18.6 yr cycle of the moon's changing declination, during which its maximum height in the sky varies by 20 of its diameters, rather than to the 11 year sunspot cycle. The effect of the moon on the Great Plains must act through gravity-induced tides. The 18.6 year cycle of the moon's declination elicits varying tides in the atmosphere just as the apparent daily motions of the moon raise tides in the atmosphere and the ocean. How the relatively weak variations of the 18.6 year cycle gain the leverage to influence the vigorous motions of the atmosphere is not clear. (Baker-IVI)
W84-04879

AUTOMATIC MAPPING OF RAINFALL DATA: STUDY OF RAINFALL - MORPHOMETRIC RELATIONSHIPS (CARTOGRAPHIE AUTOMATIQUE DES CARACTERISTIQUES PLUVIOMETRIQUES: PRISE EN COMPTE DES RELATIONS PLUVIOMETRIE - MORPHOMETRIE),
Ecole Nationale Superieure de Geologie Appliquee et de Prospection Miniere, Nancy (France).
J. P. Laborde.
La Houille Blanche, Vol. 4, p 331-338, 1982. 12 Fig, 2 Tab, 15 Ref.

Descriptors: *Automatic mapping, *Rainfall data, *Rainfall, *Rainfall distribution, Rainfall gages, Rainfall area, Rainfall index, Rainfall rate, Depth-area-duration analysis, Performance evaluation, Data acquisition, Meteorological data collection, Terrain analysis, Topography.

An automatic method for mapping rainfall parameters allows both the observations recorded in rainfall stations and the topographical factors influencing the distribution of rain to be taken into account. It is proposed that the characteristics of a site can be determined as its altitude and the depth between hills (the latter being measured by the average tangent of the angle at which the horizon is seen). It appears that the sampling of altitudes at the nodes of a square 2.5 by 2.5 km meshed network allows the topographical elements playing a leading role on rain distribution to be determined. The details of the tracing can be voluntarily limited as required for the desired specificity in the estimates of the rainfall parameters to be mapped. (Murphy-IVI)
W84-04948

AREAL RAINFALL VARIABILITY AND THE DESIGN OF A RAINFALL MONITORING NETWORK FOR SHARK RIVER SLOUGH, EVERGLADES NATIONAL PARK, FLORIDA,
Everglades National Park, Homestead, FL. South Florida Research Center.
R. M. Lew, M. D. Flora, and P. C. Rosendahl.
Florida Scientist, Vol. 47, No. 1, p 55-62, Winter, 1984. 5 Fig, 1 Tab, 5 Ref.

Descriptors: *Rainfall distribution, *Monitoring, *Forecasting, *Florida, *Shark River Slough, Everglades National Park, Networks, Rain gages.

Biweekly rainfall was measured from an 87 station rainfall monitoring networks located in Shark River Slough for 22 mo beginning in December of 1977. Cumulative rainfall for the period was 201.7 cm and ranged from 150 cm in northeastern Shark Slough to more than 230 cm in southern Shark Slough. The 87 gauge network had a mean density of 11.4 sq km/gauge and a density range of 1.04 sq km/gauge to 69.6 sq km/gauge, allowing for the detection of 90% of all showers when mean area rainfall was between 0.025 cm and 0.13 cm; and 570 sq km/gauge, allowing for detection of all rain days when mean area rainfall was greater than 1.3 cm. Based upon the areal variability of precipitation patterns, gauge density and design criteria evaluated in this study, a long-term rainfall monitoring network consiting of 8 permanent stations has been developed for the Shark River Slough. this network is symmetrically spaced and consists of standard Weather Service 61 cm gauges. (Baker-IVI)
W84-05012

STUDY OF SPACE VARIATIONS OF PRECIPITATION BY FACTOR ANALYSIS,
Ecole Polytechnique, Montreal (Quebec).
P. Beaudoin, and J. Rousselle.
Journal of Hydrology, Vol. 59, No. 1-2, p 123-138, October, 1982. 4 Fig, 4 Tab, 11 Ref. Ministere de l'Education du Quebec grant CRP-356-75.

Descriptors: *Precipitation, *Spatial distribution, *Factor analysis, *Montreal, *Quebec, Rainfall distribution, Seasonal variation.

Spatial variations in daily precipitation in the region of Montreal, Quebec are examined through factor analysis of the inter-station correlation coefficients matrices. A sample of 25 years of daily precipitation data, which were available at 19 stations, was selected for the study. Independent analyses are made for each of the four seasons of the year. Factor patterns are obtained from oblique rotation of the first six principal components of the correlation matrices. Areas in which meteorological stations have a similar factor pattern are delimited. The clustering was not very different from season to season, although the variance explained by six factors was less in summer than in the other seasons, due to the higher variability of precipitation in summer. In the Montreal region, clusters were generally formed in the Laurentians, at the foot of the Appalachian Mountains, at Montreal Island and the adjacent south shore area, and in the plains north of Montreal Island; also two clusters were formed in the south of the region which were different in shape from season to season. The whole area could be divided into only five areas having relatively homogeneous climatological characteristics. Extreme values in the data have a strong weight in the computation of the factor patterns. However, in the Montreal region, the regionalization obtained from analyses of samples containing only small values of precipitation has the same general shape as the one obtained from samples of large values. Factor analysis represents an objective way of condensing information in a meteorological network, but it must be subjected to the investigator's judgement. (Moore-IVI)
W84-05130

DERIVING RAINFALL INTENSITY-DURATION-FREQUENCY RELATIONSHIPS AND ESTIMATES FOR REGIONS WITH INADEQUATE DATA,
Lagos Univ. (Nigeria). Dept. of Geography.
L. Oyebande.
Hydrological Sciences Journal, Vol. 27, No. 3, p 353-367, September, 1982. 2 Fig, 8 Tab, 14 Ref.

Descriptors: *Nigeria, *Rainfall intensity, *Intensity-duration-frequency relationships, Regional analysis, Spatial distribution.

In order to overcome the two-fold problem of inadequate rainfall record length and coverage for Nigeria, regional analysis is used in which data for individual stations are lumped together or compounded to yield larger regional data samples. Type 1 extreme-value distribution (Gumbel) was applied to the annual extreme rainfall data sets generated by 11 rainfall zones to estimate the parameters and hence the intensity-duration-frequency (IDF) rainfall. The chi-square test confirmed the appropriateness of the fitted distribution. Gumbel graphical plots and the computed confidence limits also showed that the Gumbel EV-1 function fits well the empirical distribution. The results obtained should serve to meet the need for rainfall IDF relationships and estimates in various parts of Nigeria, both for short and long recurrence intervals. The need has been particularly great because many large basins remain inadequately gauged while some are hardly gauged at all. (Moore-IVI)
W84-05292

DISTRIBUTION OF CATCHMENT COVERAGE BY STATIONARY RAINSTORMS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
P. S. Eagleson.
Water Resources Research, Vol. 20, No. 5, p 581-590, May, 1984. 8 Fig, 3 Tab, 26 Ref. National Science Foundation grant ATM-8114723.

Descriptors: *Catchment areas, *Storms, *Model studies, Poisson distribution, Mathematical equations, Tropical regions, Thunderstorms, Sudan, Precipitation.

The fraction of a catchment's area wetted by a rainstorm occurrence within the catchment is modeled by the sum of independent random cell clusters whose stationary centers are Poisson-distributed in space and whose areas are fractals having identical (hyperbolic) pdfs. The cell clusters collected within the catchment are called catchment storms. They have specific areas and are assumed to be Poisson distributed in time. The independence, stationarity, and areal homogeneity assumptions associated with the cell clusters are met most closely by tropical air mass thunderstorms. The mean and variance of catchment average annual precipitation are derived in terms of the catchment area, the fractal dimension, the minimum cell cluster area, the maximum cell cluster area, and the two Poisson parameters. Station precipitation data from Sudan are used to evaluate the Poisson parameters. The average number of cell clusters per storm is large so that for large catchments, at least, the central limit theorem can be invoked and the entire distribution of storm area is approximated with these two moments. It should be possible to extend this work to eliminate some of the restrictive independence assumptions by introducing appropriate correlation structures and to include other storm types, both stationary and travelling. (Baker-IVI)
W84-05331

2C. Snow, Ice, and Frost

GLOBAL THERMODYNAMICS OF A POLAR ICE SHEET,
Utrecht Rijksuniversiteit (Netherlands). Inst. voor Meteorologie en Oceanografie.
C. J. Van Der Veen, and J. Oerlemans.
Tellus, Vol. 36A, No. 3, p 228-235, May, 1984. 7 Fig, 1 Tab, 13 Ref.

Descriptors: *Thermodynamics, *Polar ice sheets, Ice-water interfaces, Ice, Ice breakup, Snowmelt, Melting, Temperature effects, Drainage systems, Model studies, Flow characteristics, Antarctic.

In ice-sheet dynamics, the interaction between ice flow and temperature plays an important role. A simple approach to study the total heat budget of a drainage system is presented by investigating the global characteristics of a polar ice sheet. When looking at a drainage system as a whole, conservation of heat yields a very simple functional relation. Coupling this relation to an equation describing the large-scale dynamics of a drainage system makes it possible to study the feedback of thermodynamics on the ice-mass discharge. It is found that the temperature-ice flow feedback (including the effect of basal meltwater) can give rise to bifurcation. For certain combinations of air temperature and mass balance, two stable flow regimens are possible for a polar ice sheet: fast flow, with high basal temperatures and slow flow, with low basal temperatures. Basal melting is strongly reduced when the accumulation rate increases. Thus a polar drainage system can be brought into the fast flow regime (with meltwater present) by reducing the mass balance, or by increasing the air temperature. The calculation of the global heat budget is also applied to flow lines of the antarctic ice sheet. The flow line into the Ross Sea has at present a large imbalance. It seems that the ice sheet is cooling, and consequently, building up. (Murphy-IVI)
W84-04807

SNOW-COVER AREA VS. SNOWMELT RUNOFF RELATION AND ITS DEPENDENCE ON GEOMORPHOLOGY - A STUDY FROM THE BEAS CATCHMENT (HIMALAYAS, INDIA),
Roorkee Univ. (India). Dept. of Earth Sciences.
R. P. Gupta, A. J. Duggal, S. N. Rao, G. Sankar, and B. B. S. Singhal.
Journal of Hydrology, Vol. 58, No. 3/4, p 325-339, September, 1982. 6 Fig, 1 Tab, 13 Ref.

Descriptors: *Snow cover, *Snowmelt, *Snowmelt-runoff relationships, *Geomorphology, *Beas catchment, *Himalayas, *India, Runoff volume, Remote sensing, Satellite technology, Discharge hydrographs, Mapping.

Snowmelt forms a considerable proportion of the total runoff in many streams. Modern remote-sensing techniques using satellite platforms offer a promise for monitoring the snow cover area. The River Beas, in the northwestern part of India, was chosen to study the relation between snow-cover area and snowmelt runoff. Snow cover area was mapped from the LANDSAT images for a number of years in various subcatchments. The river discharge, excess over the baseflow, in days of non-concurrent rain-precipitation, was computed which could be attributed to snowmelt alone. The snow cover area and the subsequent snowmelt runoff in various subcatchments are found to be well correlated. It is interpreted that there have been years of uniformly heavier and lighter snowfall all over the basin and the snowmelt discharges have consequently systematically varied. For a particular subcatchment, the relationship between snow-cover area and snowmelt runoff seems to be independent of geographic factors like solar illumination, catchment orientation and relative location. On the other hand, it appears to depend on geomorphical factors such as size of the subcatchment, permanent snowcover area, average altitude, lithology and stream order. Hence, for each type of geomorphical subcatchment, a different empirical relation should exist between snowcover area and snowmelt runoff. (Murphy-IVI)
W84-04854

ICE COVER AND HYPOLIMNETIC REOXYGENATION IN THE GREIFENSEE FROM 1950 TO 1980 (EISBEDECKUNG UND HYPOLIMNISCHE SAUERSTOFFANREICHERUNG IM GREIFENSEE VON 1950 BIS 1980),
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
For primary bibliographic entry see Field 2H.
W84-04905

GREAT LAKES ICE DYNAMICS SIMULATION,
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
A. Wake, and R. R. Rumer, Jr.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 109, No. 1, February, 1983. 9 Fig, 30 Ref.

Descriptors: *Ice dynamics, *Model studies, *Great Lakes, Lakes, Thermodynamics, Ice fields, Water stress, Wind, Ice transport, Ice deformation, Simulation, Mathematical models.

A previously developed thermodynamic model for ice formation, growth, and dissipation has been

extended to account for ice transport and deformation due to wind and water stress. This ice dynamics simulation model has been designed for application to the Great Lakes to aid in forecasting ice conditions during winter navigation. By viewing the fragmented ice field conceptually as a continuum, the governing ice mass transport equations have been formulated for the Great Lakes. In the continuum representation, the internal ice stresses and ice movement are related by a constitutive law. In this study, a viscous-type constitutive law has been adopted for representing the internal stress for lake ice. The degree to which the prototype lake-ice condition is approximated by the viscous analogy is a subject for continued study. Calibration of the model application to Lake Erie will be accomplished through the use of SLAR data and ice information provided by the U.S. Coast Guard. In addition to the adjustment of the coefficients in the constitutive law, several other uncertainties remain to be resolved, including the extent to which the continuum assumption can be employed in the study of lake-ice dynamics. The developed ice dynamics simulation model may be applied to selected portions of one of the Great Lakes as well as to an entire lake. This model may be useful in estimating the time for ice dissipation where ice transport and ice melt are both important to the rate of ice disappearance. (Baker-IVI)
W84-04962

SNOW AND ICE IN A CHANGING HYDROLOGICAL WORLD,
Geological Survey, Tacoma, WA.
M. F. Meier.
Hydrobiological Sciences Journal, Vol. 28, No. 1, 3, 1983. 5 Fig, 4 Tab, 91 Ref.

Descriptors: *Hydrologic budget, *Ice cover, *Snow, Glaciers, Hydrologic cycle, Climatology, Heat flow, Solar radiation.

The world's water balance is reviewed with special emphasis on the role of snow and ice in the global hydrological climatic system. Snow cover on land (especially in the Northern Hemisphere) and sea ice (especially in the Southern Hemisphere) vary seasonally, and this seasonal change has an important effect on the world climate as snow and sea ice reflect solar radiation efficiently and affect other heat flow processes between atmosphere and land or ocean. Glaciers, including ice sheets, store most of the fresh water on Earth, but change dimensions relatively slowly. Glacier ice volume may be currently declining, but there is no clear evidence to that point. The current rise in sea level is difficult to explain. Thermal expansion of the oceans may account for half of the present rise, but the other half is uninterpreted. While major changes in the large ice sheets take place over time scales of 10,000 to 100,000 years, marine ice sheets may be subject to rapid disintegration due to grounding line instability, perhaps accompanied by surging. Ice cores may produce remarkably complete histories of air temperature, precipitation, fallout, and atmospheric composition. (Baker-IVI)
W84-05295

2D. Evaporation and Transpiration

INDIRECT MEASUREMENT OF THE LATENT HEAT FLUX OF MEADOW GRASS FROM THE ENERGY BALANCE - THE SENSIBLE HEAT FLUX BEING MEASURED BY USING THE CORRELATION TECHNIQUE,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
A. F. G. Jacobs, and C. L. Palland.
Journal of Hydrology, Vol. 58, No. 1-2, p 159-166, August, 1982. 5 Fig, 13 Ref.

Descriptors: *Heat flow, *Grasses, *Evaporation rate, Meadows, Schoonheete, Netherlands, Radiation, Soil water, Temperature effects.

Evaporation from natural surfaces may be estimated by measuring the most important energy terms near the surface. Direct measurements of net radiation, soil heat and sensible heat fluxes are continuously taken over a grass surface at Schoonheete, The Netherlands. The data are integrated over 1 hr intervals and the sensible heat is measured by using an eddy correlation technique. The results show no phase lag between sensible heat and radiation densities and a phase lag of about one hour between sensible heat and latent heat densities. An explanation for this time lag is the effect ascribed to the later peak of the vapor pressure deficit. A comparison is given between the real evaporation and the potential one. In cases described in the literature during the first hours of a day, the actual evaporation of grass equals the potential evaporation. But in the late morning a so-called depression takes place. Two reasons why this did not occur during the selected study period are: the temperature during this period was rather warm for a summer situation and, more importantly, the amount of precipitation during the preceding period had amply supplied the grass with moisture. (Baker-IVI)
W84-04845

EVAPORATION FROM VEGETATION IN LANDSCAPES DEVELOPING SECONDARY SALINITY USING THE VENTILATED-CHAMBER TECHNIQUE, IV. EVAPORATION FROM A REGENERATING FOREST OF EUCALYPTUS WANDOO ON LAND FORMERLY CLEARED FOR AGRICULTURE,
Commonwealth Scientific and Industrial Research Organization, Floreat Park (Australia). Div. of Land Resources Management.
E. A. N. Greenwood, J. D. Beresford, J. R. Bartle, and R. J. W. Barron.
Journal of Hydrology, Vol. 58, No. 3/4, p 357-366, September, 1982. 4 Fig, 3 Tab, 4 Ref.

Descriptors: *Evaporation, *Vegetation, *Salinity, *Ventilated-chamber, *Regenerating forest, *Eucalyptus wandoo, Leaves, Saline water intrusion, Trees, Evaporation area, Evaporation discharge, Aeration zone.

Daily evaporation from five regenerating trees, ranging in leaf area from 1-70 sq m, and from areas of pasture near them, was periodically measured over a year. The aim was to obtain indirect evidence of the ability of regenerating trees to take up a significant quantity of water from a phreatic aquifer which was causing secondary salinity downslope. In the spring and early summer daily evaporation rates varied greatly between sampling occasions, the main influences being the physical nature of the day, the timing of the yearly flush of leaf growth and intense attacks of leaf-eating insects. From mid summer to late autumn, evaporation was low at all times, implying that the supply of soil water was limiting. This view is supported by concurrently low values of soil water content and by the failure of excavation to reveal a deep root system. A close relationship (sq R = 0.99) was found between the average value of evaporation over the year for each tree (y) and its plan area (x) on an aerial photograph. The relationship was used to estimate evaporation from the trees on a ground area basis. The results suggest that uptake of water by the trees was limited mainly to the unsaturated zone and that the trees did not discharge a substantial quantity of water from the phreatic aquifer. (Author's abstract)
W84-04856

EVAPOTRANSPIRATION LOSSES OF TOMATOES UNDER DRIP AND FURROW IRRIGATION,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 3F.
W84-04888

DIURNAL RELATIONSHIP BETWEEN EVAPOTRANSPIRATION AND LEAF WATER POTENTIAL OF FIELD-GROWN SOYBEANS,
Agricultural Research Service, Morris, MN.
D. C. Reicosky, T. C. Kaspar, and H. M. Taylor.
Agronomy Journal, Vol. 74, No. 4, p 667-673, July-August, 1982. 6 Fig, 18 Ref.

Descriptors: *Evapotranspiration, *Water potential, *Soybeans, Row spacing, Hysteresis, Diurnal variation, Irrigation effects, Canopy, Soil water.

The diurnal relationship between evapotranspiration (ET) and leaf water potential (Theta) were investigated for field grown soybeans (Glycine max) as affected by row spacing and irrigation on an Ida silt loam (fine, silty, mixed (calcareous) mesic family of Typic Udorthents). ET and Theta were determined in detail on 2 days in the 1979 growing cycle, one just preceding canopy closure (11 July) and the second at the midpod fill stage (1 August). Theta was measured by using a pressure chamber technique, and ET was measured by using a portable chamber. The relationship between Theta and ET was similar on both days, for both row-spacing treatments. Nonirrigated treatments demonstrated a slight hysteresis in the Theta ET relationship; irrigated treatments did not. The interaction of the variable root density and soil water status with depth does not allow any definte conclusions about the direct cause of the hysteresis. The ET at a given Theta was much greater on 1 August than on 11 July, probably because of an increase in soil evaporation caused by a recent rainfall and an increase in transpiration due to the increased leaf area index. The Theta ET relationship seemed to be affected more by irrigation than by row spacing. The simplified Ohm's Law analogy does not seem to adequately describe the relationship of plant water flux to resistance and potential difference under field conditions. (Moore-IVI)
W84-04986

MOISTURE DEFICITS AND GRAIN SORGHUM PERFORMANCE: EVAPOTRANSPIRATION-YIELD RELATIONSHIPS,
D. P. Garrity, D. G. Watts, C. Y. Sullivan, and J. R. Gilley.
Agronomy Journal, Vol. 74, No. 5, p 815-820, September-October, 1982. 5 Fig, 3 Tab, 22 Ref.

Descriptors: *Evapotranspiration, *Crop yield, *Sorghum, *Water deficits, *Nebraska, Water stress, Water use efficiency, Water management, Irrigation requirements.

Evapotranspiration-yield (ET-Y) functions were developed for grain sorghum (Sorghum bicolor), to provide base data for a water management improvement study in Nebraska. A modified line source sprinkler system was installed on a Valentine very fine sand (Typic Ustipsament) in west central Nebraska. In two seasons the relationship betweer. evapotranspiration (ET) and grain yield (Y) or dry matter was linear. Evapotranspiration reduction under all conditions tested incurred some yield reduction. For a given genotype the slope of the ET-Y relationship varied greatly depending on the growth period treatment. The lowest slopes were associated with a treatment in which stress built up steadily over the entire growing season. The slope was generally much steeper when irrigation was restricted to varying degrees for only a portion of the growing season. With greater yield reductions per unit of ET deficit, the latter treatments were considered suboptimal irrigation strategies compared to a gradual stress buildup. One hybrid had a lower slope of the ET-Y relationship than the other genotypes for the treatment that provided water stress of gradually increasing severity. Percentage yield reductions were similar for all hybrids. The yield reduction ratios of the genotypes were different for the two growing seasons. Water use efficiency consistently decreased as ET declined below the maximum. Water stress, regardless of timing, tended to reduce water use efficiency. The reductions were smallest when stress increased gradually throughout the growing season. (Moore-IVI)
W84-04989

WATER DEFICITS AND MINERAL UPTAKE IN RICE,
International Rice Research Inst., Los Banos, Laguna (Philippines). Dept. of Agronomy.
J. C. O'Toole, and E. P. Baldia.
Crop Science, Vol. 22, No. 6, p 1144-1150, November-December, 1982. 6 Fig, 2 Tab, 24 Ref.

Descriptors: *Rice, *Water stress, *Transpiration, *Nitrogen, *Phosphorus, *Potassium, Water poten-

tial, Evaporative demand, Soil water potential, Water potential.

Soil and plant water deficits are commonly related to decreased rate of crop evapotranspiration, but the relationship of transpiration to uptake of N, P, and K during water stress not well documented. The ratio of actual (stress) to potential (control) transpiration in conjunction with leaf and soil water potential to investigate the relationship between transpirational flux and uptake of N, P, and K by water stresses rice (Oryza sativa) grown in containers. Soil and plant water potential, transpiration rate, leaf area, dry weight, uptake of N, P and K and atmospheric evaporative demand were monitored over an 18 day drying period. Decreased transpiration rate was the most sensitive variable to water stress. Transpiration of the stress treatment differed significantly from control plants when soil water potential was in the range -0.02 to -0.15 MPa. Dawn leaf water potential, alternately used to estimate soil water potential, was between -0.06 and -.025 MPa when transpiration and N, P and K uptake of stressed plants derived from control plants. Transpiration and nutrient uptake were highly correlated during the development of even mild soil and plant water stress. Although these results must be carefully extrapolated to multilayer soil conditions, they may be relevant for young plants of many crops where the root system is not well developed vertically or where soil physical or chemical barriers limit the soil volume for root growth. (Moore-IVI)
W84-05008

EFFECT OF SOIL MOISTURE STRESS TO VARIOUS FRACTIONS OF THE ROOT SYSTEM ON TRANSPIRATION, PHOTOSYNTHESIS, AND INTERNAL WATER RELATIONS OF PEACH SEEDLINGS,
Department of Agriculture, Harrow (Ontario). Research Station.
C. S. Tan, and B. R. Buttery.
Journal of American Society of the Horticultural Science, Vol. 107, No. 5, p 845-849, 1982. 2 Fig, 4 Tab, 14 Ref.

Descriptors: *Peaches, *Water stress, *Transpiration, *Roots, Soil water, Photosynthesis, Stomatal conductance, Wilting, Xylem pressure potential, Plant growth.

Peach (Prunnus persica (L.) Batsch) seedlings were grown in large sectional boxes with root systems divided into 4 separate quadrants. Groups of peach seedlings with 3, 2, 1, and 0 quadrants of the root system deprived of water for 3 weeks, were further subjected to moisture stress in all quadrants by withholding water for 5 days, and they were then rewatered. In another treatment, seedlings were subjected to 2 cycles of water stress, applied 3 weeks apart, by completely depriving all quadrants of water until the plants wilted. Transpiration, photosynthesis, stomatal conductance, and xylem pressure potential were measured. Subjecting a large portion of the root (50%) to stress by withholding water only caused a small reduction (17%) in transpiration, photosynthesis, and stomatal conductance. Subjection of various fractions of the root system to severe moisture stress did not affect the shoot:root ratio. The reduction in root growth in dry quadrants was accompanied by the production of more roots in wet quadrants and less transpiring leaf surface and branch growth. The rate of recovery of transpiration and photosynthesis from water stress was greatly influenced by the duration and intensity of wilting as well as by the rate of regeneration of new root systems. (Author's abstract)
W84-05065

PRELIMINARY QUANTIFICATION OF THE IMPACTS OF ASPEN TO CONIFER SUCCESSION ON WATER YIELD - I. HEAT PULSE METHODOLOGY FOR MODEL CALIBRATION,
Utah State Univ., Logan. Watershed Science Unit.
W. Humphries, and G. F. Gifford.
Water Resources Bulletin, Vol. 20, No. 2, p 173-178, April, 1984. 3 Fig, 1 Tab, 42 Ref. OWRT project B-175-Utah, OWRT grant 14-34-0001-0138.

Descriptors: *Transpiration, *Heat pulse velocity, *Trees, Aspen, Fir, Spruce, Sap velocity, Plant activity index, Plant populations, Succession, Water yield.

Studies using heat pulse velocity (HPV) techniques to measure transpiration were conducted on three tree species in the Wasatch Mountains (Utah). Twenty-six aspen, 20 subalpine fir and 20 Engelmann spruce of various sizes were cut under water and suspended in permanent reservoirs at the site. The reservoirs were sealed so that all water loss was due to consumption by the trees. Sap velocities, as computed from HPV, were related to conducting areas of the tree trunks. Computed transpiration volumes were then correlated with actual water losses from the reservoirs. Coefficients of determination (R2) of 0.87, 0.86, and 0.82 were obtained for the fir, aspen, and spruce, respectively. Reservoir water loss for each species for each season was then used to adjust a plant activity index for computing transpiration within ASPCON, a model describing the hydrology of aspen to conifer succession. The plant activity index reflects the variation in the capability of a plant community to transpire water over the year. The developed correlations of actual and computed flows, as well as total and water conducting cross-sectional areas, may be somewhat site specific. (Moore-IVI)
W84-05155

DISTRIBUTION OF DEUTERIUM AND 18-O IN DRY SOILS. 1. THEORY,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
C. J. Barnes, and G. B. Allison.
Journal of Hydrology, Vol. 60, No. 1-4, p 141-156, January, 1983. 2 Fig, 13 Ref.

Descriptors: *Evaporation, *Mathematical models, Model studies, Isotope studies, Temperature, Humidity, Soil water, Slope, Arid lands.

A mathematical model is developed describing the shape of H2(18)O and HDO depth profiles which result from evaporation of water from dry soil under quasi-steady state conditions. Typically, isotope concentrations rise from a minimum at the soil surface to a maximum a short distance beneath the surface, and then decrease approximately exponentially to constant concentrations at depth. The model predicts that for isothermal conditions, the slope of the relationship between O-18 and deuterium delta-values of samples of the soil water will be about 30% lower for a dry soil than for a wet soil evaporating under the same conditions. Low slopes should be indicative of soil water or groundwater recharged under arid or semi-arid conditions. Using the shape of the O-18 and deuterium profiles, three independent methods for estimating evaporation for dry soils are developed. When water loss occurs by both transpiration and evaporation, the slope of the O(18)-D relationship should be slightly lower than that for a site where water loss occurs by evaporation alone. Each of the three methods is applicable to both D and O-18 data, so that if complete data are available, there is an independent check on each method. For a strictly equilibrium and isothermal profile, the estimate made using the decay length is probably the most accurate. However, in more complicated situations where the profile may not be in complete equilibrium, or when plants are transpiring, the concept of a decay length is irrelevant. The estimate made using the depth of the maximum delta-value is probably more robust, as it is effectively an instantaneous estimate of the evaporation rate. (Baker-IVI)
W84-05353

EVAPORATION DATA FROM A PICHE EVAPORIMETER,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
A. F. G. Jacobs, and E. E. L. Arriens-Bekker.
Journal of Hydrology, Vol. 60, No. 1-4, p 367-380, January, 1983. 10 Fig, 7 Ref.

Descriptors: *Evaporation, *Evaporimeter, Measuring instruments, Evaporation rate, Piche evaporimeters.

Measurements have been conducted with Piche evaporimeters within a thermometer screen over a grass surface at several heights. The results show a good correlation with model calculations but differ somewhat in absolute value. With a simple factor, or with a lower measuring position, the results can be brought into better agreement. The comparison between the results of the De Vries and Venema model (De Vries, D. A. and Venema, H. J., 1953. Vegetation, 5/6: 225-234.) with the readings showed a systematic overestimate of about 30%. The model of Stigter and Uiso (Stigter, C. J., and Uiso, C. B. S., 1981. Appl. Sc. Res., 37: 213-223,) showed an underestimation of about 15%, probably caused by omitting the supplied energy term. A Piche evaporimeter is highly sensitive to wind effects which mainly will result in overestimation of evaporation data. (Baker-IVI)
W84-05367

2E. Streamflow and Runoff

CONFIDENCE INTERVALS FOR DESIGN EVENTS,
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
J. R. Stedinger.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p 13-27, January, 1983. 1 Fig, 10 Tab, 25 Ref. NSF grant CME 8010889.

Descriptors: *Confidence intervals, *Design criteria, *Floodplain management, Quantile, Flood flow, Pearson Type III distributions, Mathematical equations, Mathematical models, Mathematical studies, Flood frequency.

An important problem in hydrology is the estimation of some quantile of a streamflow or flood-flow distribution. For example, the 100-year flood, corresponding to the 99 percentile of the annual flood-flow distribution, is used in floodplain management and planning. Confidence intervals for normal, log-normal, and Pearson Type III quantiles based on asymptotic theory are shown to fail to contain the true 100-year flood and other design events with the specific frequency (confidence level). Intervals which contain normal and lognormal quantiles with the desired confidence can be constructed using the noncentral t-distribution. Tables are provided. An adjustment for the case when a variable has a Pearson Type III distribution with known skewness coefficient is suggested. Such intervals are shown to contain design events with nearly the desired level of confidence. Confidence intervals constructed using the U.S. Water Resources Council guidelines, Bulletins 17A and 17B, often did not achieve the desired confidence level. (Murphy-IVI)
W84-04821

TWO-DIMENSIONAL CHANNEL FLOWS OVER ROUGH SURFACES,
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
N. L. Coleman, and C. V. Alonso.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 175-188, February, 1983. 4 Fig, 1 Tab, 25 Ref.

Descriptors: *Multiphase flow, *Channel flow, *Rough surfaces, Reynolds number, Mathematical equations, Velocity, Viscosity, Model studies.

A single equation model for pedicting the velocity profile throughout the complete inner and outer regions of channel or conduit flow is presented. The model predicts within 20% of measured data in the logarithmic zones of velocity profiles when tested against channel and conduit flows with either smooth boundaries or planar boundaries of granular material with scaled equivalent sand grain boundary roughness values ranging up to 2,075. The absolute value mean predictive error with the data sets used here was 9%. The equation predicts the velocity profile in the viscous sublayer, the buffer zone, the logarithmic or inertial zone, and

the outer or wake region in conduit and channel flows provided that secondary or crossflow is weak or absent. (Baker-IVI)
W84-04827

EFFECTIVE IMPERVIOUS AREA IN URBAN RUNOFF MODELING,
Geological Survey, Reston, VA.
W. M. Alley, and J. E. Veenhuis.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 313-319, February, 1983. 2 Tab, 11 Ref.

Descriptors: *Urban runoff, *Model studies, *Impervious areas, Runoff, Denver, Colorado, Metropolitan water management, Urban areas.

Methods of estimating impervious areas are described and some effective impervious area data is summarized. The ramifications of effective impervious area concepts in urban runoff modeling are analyzed. Results from many urban runoff models are sensitive to the value used for impervious area. Large differences in results can be obtained depending on whether total impervious area (TIA) or effective impervious area (EIA) calculations are used. TIA may be appropriate for black-box models but not for deterministic ones. Potential problems of using TIA in the more deterministic models include: runoff volumes and peak flows may be largely overestimated for ungaged watersheds; simulated changes in runoff, on a percentage basis, due to increasing intensity of land use may be smaller if TIA is used rather than EIA; and overestimates of the infiltration rates are likely if the model is calibrated using TIA and measured rainfall-runoff data. Impervious area data collected from 19 urban watersheds in the Denver metropolitan area suggest a large potential exists for developing relationships between EIA and TIA for an urban area, either through a regression equation between the two variables or through estimates of the ratio EIA-TIA as a function of land use. (Baker-IVI)
W84-04834

FLOOD FREQUENCY ANALYSIS WITH HISTORIC INFORMATION,
Inland Waters Directorate, Ottawa (Ontario).
R. Condie, and K. A. Lee.
Journal of Hydrology, Vol. 58, No. 1-2, p 47-61, August, 1982. 1 Fig, 5 Tab, 7 Ref.

Descriptors: *Flood frequency, *Frequency analysis, *History, Flood data, Mathematical studies, Regional analysis, Frequency distribution, Flood forecasting, Monte Carlo method.

Within the limits of available real data and the Monte Carlo experiment, a reliable maximum likelihood method is presented for fitting the three-parameter lognormal distribution to flood series with historic information. The maximum likelihood method, although biased, gives estimates both of parameters and T-yr. events which are substantially less biased in the absolute sense than those obtained by the more conventional method of historically weighted moments. Maximum likelihood estimates also give significantly smaller root mean square errors of estimates of parameters about their true values, although for some T-yr. events, the moment fit is better in this respect. Overall, the proposed maximum likelihood method seems preferable to the conventional method of historically weighted moments. (Baker-IVI)
W84-04838

EFFECTS OF CATCHMENT SIZE ON RUNOFF RELATIONSHIPS,
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
D. H. Pilgrim, I. Cordery, and B. C. Baron.
Journal of Hydrology, Vol. 58, No. 3/4, p 205-221, September, 1982. 3 Fig, 70 Ref.

Descriptors: *Catchment size, *Runoff, *Catchment basins, *Catchment areas, Drainage area, Unit hydrographs, Hydrographs, Rainfall-runoff relationships.

Concern has often been expressed that the hydrological processes and relationships on small catchments may not be representative of those on larger catchments, and that the relative importance of the various processes on the two types of catchments are different. The transfer of results to large catchments is of obvious practical importance. Factors that affect hydrological relationships between small and large catchments are reviewed, including the various processes and mechanisms by which runoff occurs, catchment characteristics such as land use, soils and geology, the variation of geomorphological characteristics with catchment size, small-scale nonhomogeneity of hydrological characteristics, and data errors. Hydrological responses of small catchments are likely to be different from and more variable than those of large catchments. While general relationships will exist between small and large catchments in a region, no simple or closely defined relations are likely. The transfer of many types of relationships from one region to another is also likely to be invalid. The findings of the review are illustrated by the results of an investigation of relationships between small and large catchments in eastern Australia involving annual rainfall-runoff relations, unit hydrograph parameters and storm loss rates. (Murphy-IVI)
W84-04847

SNOW-COVER AREA VS. SNOWMELT RUNOFF RELATION AND ITS DEPENDENCE ON GEOMORPHOLOGY - A STUDY FROM THE BEAS CATCHMENT (HIMALAYAS, INDIA),
Roorkee Univ. (India). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2C.
W84-04854

APPLICATION OF HOT-WIRE (-FILM) FLOWMETERS TO WATER VELOCITY MEASUREMENTS IN WELLS,
Imperial Coll. of Science and Technology, London (England). Div. of Engineering Geology.
A. Tselentis.
Journal of Hydrology, Vol. 58, No. 3/4, p 375-381, September, 1982. 2 Fig, 16 Ref.

Descriptors: *Flow velocity, *Measuring instruments, *Hot-wire flowmeters, *Hot-film flowmeters, Wells, Flowmeter, Velocity, Water velocity, Flow.

Hot wires have been used for a long time for the measurement of air speeds, where they are particularly suitable for relatively small velocities. Hot wire (-film) flowmeters are by no means a panacea for well born fluid flow measurements, but the device could be valuable if made to work accurately in water. Its sensitivity increases with decreasing velocity; it could therefore be used to great advantage to measure those low velocities where an impeller flowmeter is not satisfactory. Unfortunately there are many problems to be solved and up to now thermal flowmeters can be considered to be of little practical value for water velocity measurements in wells. Presently, a new device is under theoretical and experimental investigation and has shown considerable promise in water velocity measurements as low as 1 mm/s. It uses the thermal wake of a heated wire, submerged in the water as a tracer. Important advantages of the heat-pulse method are its stability and repeatability over a wide dynamic range in a wide variety of conditions. The high electrical conductivity of water, its low boiling point, its temperature-dependent viscosity, and the large number of suspended particles found in well waters are some factors which make the behavior in water of the hot-wire (-film) flowmeter very complicated. (Baker-IVI)
W84-04858

STATISTICAL ANALYSIS OF THE DAILY STREAMFLOW HYDROGRAPHY,
Kentucky Univ., Lexington. Dept. of Civil Engineering.
M. L. Kavvas, and J. W. Delleur.
Journal of Hydrology, Vol. 71, No. 3/4, p 253-275, March, 1984. 8 Fig, 1 Tab, 14 Ref. OWRT grant OWRT-B-112-IND.

Descriptors: *Statistical analysis, *Stream discharge, *Daily hydrographs, Discharge hydrographs, Model studies, Mathematical equations, Hydrologic models, Indiana.

In planning studies of a water-resources system for water-supply, irrigation and flood-control purposes, daily or smaller-time-increment streamflows are routed through the envisaged reservoirs to evaluate their performance. A periodic statistical analysis of daily streamflow data in Indiana, U.S.A., was performed to gain some new insight into the stochastic structure which describes the daily streamflow process. This analysis was performed by the periodic mean and covariance functions of the daily streamflows, by the time and peak discharge dependent recession limb of the daily streamflow hydrograph, by the time and discharge exceedance level (DEL) dependent probability distribution of the hydrograph peak interarrival times, and by the time-dependent probability distribution of the time to peak discharge. Some new statistical estimators were developed and used in this study. In general features, this study has shown that: (a) the persistence properties of daily flows dependent on the storage state of the basin at the specified time origin of the flow process; (b) the daily streamflow process is time irreversible; (c) the probability distribution of the daily hydrograph peak interarrival time depends both on the occurrence time of the peak from which the interarrival time originates and on the discharge exceedance level; and (d) if the daily streamflow process is modeled as the release from a linear watershed storage, this release should depend on the state of the storage and on the time of the release as the persistence properties and the recession limb decay rates were observed to change with the state of the watershed storage and time. Therefore, a time-varying reservoir system needs to be considered if the daily streamflow process is to be modeled as the release from a linear watershed storage. (Murphy-IVI)
W84-04863

SPATIAL DEPENDENCY OF HYDRAULIC GEOMETRY EXPONENTS IN A SUBALPINE STREAM,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
P. J. Phillips, and J. M. Harlin.
Journal of Hydrology, Vol. 71, No. 3-4, p 277-283, March, 1984. 2 Fig, 3 Tab, 9 Ref.

Descriptors: *Hydraulic geometry, *Subalpine streams, Spatial distribution, Model studies, Streamflow, Velocity, Mathematical equations, Soil water.

Analysis of a subalpine stream in a relatively homogeneous environment indicates that hydraulic exponents are not stable over space. A question as to the applied value of this model is raised by inequalities in continuity parameters derived from the hydraulic geometry equations. It becomes exceedingly difficult to discern real meaning in hydraulic geometry exponents as the longitudinal stream profile under examination lengthens. The meadow environment examined in this study produced one set of equations, but as data were disaggregated the exponents projected little stability. It seems a clear picture of the influence from geology-soil relationships, widening and narrowing floodplains, upstream bog and marsh environments, or network topologies, is lost as hydraulic geometry is assessed over even limited channel reaches in carefully controlled environments. Employing the hydraulic geometry model to answer questions pertaining to channel storage, flood potential, or sediment delivery would seem to prove difficult at best without constant re-evaluation in steady state time. An inherent difficulty in the model is that the feedback in the system produces variables which, even in the short run and at a station are never consistently dependent or independent. (Baker-IVI)
W84-04864

CHANGES IN THE HYDROLOGIC REGIME OF THE BATTLE RIVER BASIN, ALBERTA, CANADA,

Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
W. J. Stolte, and R. Herrington.
Journal of Hydrology, Vol. 71, No. 3/4, p 285-301, March, 1984. 7 Fig, 4 Tab, 20 Ref.

Descriptors: *Hydrologic aspects, *Battle River basin, *Alberta, *Canada, Battle River, Net rainfall, Evapotranspiration, Drainage area, Catchment areas, Cumulative runoff, Snowmelt, Streamflow depletion, Land use.

Flow records of the Battle River, Alberta, include those taken near Ponoka for a period in the early part of the century and those taken at the same location recently. Some questions have arisen as to whether these two sets of records can properly be combined for purposes of water-resource development. An investigation was made into whether a significant decrease in flows had occurred and if so, what caused the change. The reductions in the mean monthly flow were analyzed statistically and changes identified. Variations in the precipitation regime included changes in the evapotranspiration regime and shifts in landuse and agricultural practices. Monthly flows of the Battle River near Ponoka from 1967 and 1979 were found to be significantly reduced from the level that prevailed from 1914 to 1932, except for spring flows. Spring flows remained virtually unchanged thereby indicating that the snow accumulation and snowmelt processes had not changed with time. The reductions in summer and winter flows indicated that the quickflow reponse of the basin to summer storms and also the delayed flow from soil-moisture drainage had decreased. Analysis of daily and monthly precipitation characteristics showed that changes in precipitation characteristics could not be considered responsible for most of the runoff changes. An increase in growing-season temperatures resulting in increased evapotranspiration is a possible partial cause of the decreased flows. Greatly increased use of fertilizer since 1950 has caused a substantial increase in crop yields. In all likelihood this increase has created a major increase in water use leading to a drop in soil-moisture content and then reductions in streamflow. Winter recharge of soil moisture from depth as reported in the literature were the probable reason for little change in snowmelt runoff. A lack of change and even increases in runoff production in the lower Battle River basin were due to generally lower moisture surpluses in the region, thus there was less sensitivity to fertilizer application rates, and also much lower rates of fertilizer application. (Murphy-IVI)
W84-04865

TURBULENT SHEAR-STRESSES AND VELOCITY DISTRIBUTION IN OPEN-CHANNEL FLOWS (CONTRAINTES TANGENTIELLES TURBULENTES ET DISTRIBUTION DES VITESSES DANS LES ECOULEMENTS A SURFACE LIBRE),
Rome Univ. (Italy).
B. Gaddini, and M. Morganti.
La Houille Blanche, Vol. 4, p 309-326, 1982. 11 Fig, 1 Tab, 11 Ref.

Descriptors: *Turbulent shear stresses, *Shear stress, *Velocity distribution, *Open-channel flow, Turbulent flow, Hydraulic friction, Hydraulic properties, Hydrodynamics, Velocity coeficient, Mathematical equations, Karman's constant, Boundary conditions.

To determine the velocity field and the friction factor in open-channels with sufficient accuracy, it is necessary to evaluate the effects both of the shape of the cross-section and of the non-uniform distribution of the shear-stresses over the wetted perimeter. These factors in fact determine a three-dimensional flow in open channels. Measurements of turbulent shear-stresses and of mean velocities in an open-channel flow were carried out using a hot-film anemometer. The lines of zero shear-stress on the cross-section were deduced in the case of a three-dimensional turbulent flow. On the cross-section, the lines along which shear-stresses prove to be zero in the axial direction of the flow may be taken as orthogonals to the isolvels. Even when considerable distortions of the flow fields exist, the mean axial velocity shows a logarithmic distribution along the lines of zero shear. A logarithmic law of mean velocity distribution along the lines of zero shear involves values of Karman's constant which vary along the wetted perimeter in accordance with the boundary conditions on the cross-section. (Murphy-IVI)
W84-04947

LAMINAR FLOW VELOCITY PROFILE OVER CLOSE-PACKED SPHERICAL ROUGHNESS ELEMENTS (LE PROFIL DES VITESSES EN ECOULEMENT LAMINAIRE SUR UN FOND D'ELEMENTS DE RUGOSITE SPHERIQUES JOINTIFS),
Science and Education Administration, Oxford, MS. Sedimentation Lab.
N. L. Coleman.
La Houille Blanche, Vol. 1, p 13-12, 1982. 6 Fig, 1 Tab, 7 Ref.

Descriptors: *Laminar flow, *Velocity distribution, *Close-packed roughness, *Roughness coefficient, Hydraulic roughness, Hydraulic properties, Hydraulic friction, Hydraulic profiles, Reynolds number, Reynolds model, Flow characteristics.

Laminar bounded shear flows are usually considered only with regard to flow over smooth surfaces, without roughness elements of any kind. Little is known about laminar flow over a surface with roughness elements, even though this is a situation that arises fairly often in connection with the movement of very viscous fluids through conduits of different kinds and specifically in the experimental study of low Reynolds number flow over sediment beds. Methods are presented for calculating the virtual origin correction, the local friction coefficient, and the bed shear velocity for laminar flow over close-packed spherical roughness elements. The validity of these methods is tested using measured velocity profiles from 16 laminar flows over a bed composed of close-packed spherical roughness elements in the rectangular conduit of a water tunnel. When the virtual origin correction is introduced into the equation for laminar flow between parallel boundaries, the equation universally represents the data, except for a region of deviation immediately adjacent to the roughness elements. Conversely, omission of the virtual origin correction from the equation results in error in the calculation of the bed shear velocity and in loss of universality in representation of the velocity profiles. (Murphy-IVI)
W84-04949

DOCUMENTATION OF HIGH SUMMER FLOWS ON THE POTOMAC RIVER FROM THE WOOD ANATOMY OF ASH TREES,
Geological Survey, Reston, VA. Water Resources Div.
T. M. Yanosky.
Water Resources Bulletin, Vol. 20, No. 2, p 241-250, April, 1984. 4 Fig, 1 Tab, 6 Ref.

Descriptors: *Potomac River, *Ash trees, *High flow, *Dendrochronology, Streamflow, Floodplains, Plant growth, Flow discharge, Hydrologic data, Data reconstruction.

Ash trees (Fraxinus americana L. and F. pennsylvanica Marsh.) collected from the flood plain of the Potomac River near Washington, D.C., were studied for evidence of associations between known periods of above-average summer flows and changes in wood-growth anatomy. Concentric bands of latewood fibers with atypically large lumens and thin walls commonly developed in trees growing near the low-water channel. Discharge records indicate that roots of most trees with these 'white rings' were flooded temporarily during the latewood-growth interval. Trees apparently were not damaged and a concomitant reduced of internal water stresses seems to have accelerated the rate of radial growth. The intraring position of anomalous fibers generally corresponded to the time of increased discharge within the estimated interval of latewood growth. Anomalous fibers occasionally formed in unflooded trees, but their position also coincided with episodes of increased discharge. The results of these studies may have applications for stream-flow reconstruction techniques where hydrologic data are incomplete or lacking. (Author's abstract)
W84-05165

INLET CONCENTRATION TIME NOMOGRAM FOR URBAN BASINS,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
A. P. Akan.
Water Resources Bulletin, Vol. 20, No. 2, p 267-270, April, 1984. 3 Fig, 8 Ref.

Descriptors: *Urban runoff, *Kinematic waves, Inlet concentration time, Nomogram, Surface runoff, Drainage, Rainfall intensity, Rainfall, Storm runoff.

Inlet concentration time represents the longest travel time to an inlet for surface runoff. A physically based nomogram to determine inlet concentration times for composite developed basins is presented. The nomogram is constructed from previously derived kinematic wave formulations of both catchment and gutter flow components of surface runoff. With specified physical properties of a basin and rainfall intensity duration relationships the inlet time can be obtained from the nomogram directly. As the proposed method is physically based, it is applicable not merely to a certain region or to special flow conditions. It can be employed for a variety of different types of composite basins within the limitations of the kinematic-wave theory. The method requires detailed information for each drainage area, but all the parameters involved are defined reasonably well and can be either measured or obtained from widely used tables. Such information would be needed even if an empirical formula were adopted to calculate inlet concentration times. The nomogram derived is especially useful when a city engineer or design engineer must repeat the process of calculating the inlet concentration time for many widely varied areas within a city or subdivision. (Baker-IVI)
W84-05168

FLOOD ESTIMATION IN GREAT BRITAIN (BESTIMMUNG DER HOCHWASSERABFLUSSE IN GROSSBRITANNIEN),
Institute of Hydrology, Wallingford (England).
M. A. Beran.
Wasserwirtschaft, Vol. 73, No. 4, p 120-125, April, 1983. 3 Fig, 1 Tab, 3 Ref.

Descriptors: *Flood studies report, *Flood forecasting, *Flood estimating, Flood hydrographs, Flood data, Flood profiles, Flood protection, Flood recurrence interval, Great Britain, Hydrologic models.

A very large program of research to frame recommendations for flood prediction which culminated with the Flood Studies Report is described. Although this report has found ready application in Britain many important questions were unanswered. This has prompted an extension incorporating data from mainland Europe. Current activities of the European Flood Study are also described. The study develops regional flood curves for Britain and Ireland. The program categorizes or rates the possible flood conditions. (Murphy-IVI)
W84-05239

DIFFUSION AND DISPERSION IN STREAMS (DIFFUSION UND DISPERSION IN FLUSSEN),
Karlsruhe Univ. (Germany, F.R.).
J. Grimm-Strele.
Wasserwirtschaft, Vol. 73, No. 11, p 380-385, November, 1983. 8 Fig, 2 Tab, 19 Ref.

Descriptors: *Diffusion coefficient, *Dispersion coefficient, *Flow characteristics, Mixing phenomena, Mixing capacity, Mathematic analysis, Mathematic models, River flow, River mechanics.

Dispersion models are helpful in assessing river flow suppression. Field experiments of mixing phenomena in rivers indicated a large increase in the mixing capacity in some of the sharp bends. In further laboratory experiments the mixing in straight flumes and the exchange between river and lateral dead zones was investigated. Numerical and graphical analysis is represented illustrating pertinent mixing coefficients. (Murphy-IVI)
W84-05256

NUMERICAL CALCULATION OF TURBULENT TRANSPORT PROCESSES IN WATER BODIES (NUMERISCHE BERECHNUNG TURBULENTER AUSBREITUNGSBORGANGE IN GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 5B.
W84-05257

FLASH FLOOD OF JULY 1979 IN THE LUNI BASIN - A RARE EVENT IN THE INDIAN DESERT,
Central Arid Zone Research Inst., Jodhpur (India).
K. D. Sharma, and N. S. Vangani.
Hydrological Sciences Journal, Vol. 27, No. 3, p 385-397, September, 1982. 10 Fig, 4 Tab, 13 Ref.

Descriptors: *Flash floods, *Luni Basin, *India, *Arid zone, Monsoons, Soil saturation, Suspended sediments, Stream erosion, Scour, Dissolved solids.

A well marked low pressure monsoon depression caused unprecedented heavy rainfall of five days duration (15-19 July 1979) in the Luni basin in the India arid zone. It caused the worst flash flood in living memory. Saturated antecedent soil moisture conditions, thin soil cover underlain by bed rock or hardpan, a larger area of exposed rocks in the basin and failure of the earthen reservoirs further worsened the flood effect. During flooding, suspended sediment concentrations rose from 0.86 to 40.2 g/l downstream due to bank scouring, erosion and high transmission losses of the runoff volume in the alluvial channels. The dilution effect of flooding caused lower concentrations of the total dissolved solids which increased with downstream travel. Social effects of this flood and consequences on future planning in the Luni basin have also been discussed. (Author's abstract)
W84-05294

STREAMFLOW GENERATION REGARDING STORAGE COMPONENTS AND RUNS' CHARACTERISTICS,
Asian Inst. of Tech., Bangkok (Thailand).
H. N. Phien, and H. K. M. Vithana.
Journal of Hydrology, Vol. 60, No. 1-4, p 1-12, January, 1983. 2 Fig, 3 Tab, 19 Ref.

Descriptors: *Storage reservoirs, *Model studies, *Streamflow, Hydrologic models, Performance evaluation.

An attempt is made to search for a model which is capable of reproducing the reservoir storage components and runs' characteristics along with the mean, standard deviation, skewness and correlation coefficients of historical monthly streamflows. The model is based on the method of fragments and a scheme devised for annual values yields satisfactory results and is recommended for use. The method is simple in form and easy to employ. Results are presented of the case of a station on the Pking River at Nawarat Bridge, Thailand. (Baker-IVI)
W84-05345

STREAMFLOW FORECASTING IN REMOTE AREAS,
Roorkee Univ. (India). Dept. of Civil Engineering.
K. P. Sharma, and R. H. McCuen.
Journal of Hydrology, Vol. 60, No. 1-4, p 13-23, January, 1983. 1 Fig, 3 Tab, 10 Ref.

Descriptors: *Streamflow, *Forecasting, *Model studies, Hydrologic models, Watersheds, India, Remote areas, Remote sensing, Sont Watershed, Muna Watershed.

There is a need to develop and test hydrological models that require a minimal input data base; are conceptually simple, and therefore easy to transfer; and are valid for large watersheds, many of which are in remote areas. It is also advantageous to have a model that can use remotely sensed data as a major input. Data are used from two watersheds in India to compare a selection of model structures, calibrate a distributed seasonally-varying model, and test the model with data that were independent of the data used to calibrate it. The study was limited to the analysis of water supply forecasting models that require only the size of the watershed, the land use, and estimates of the volume of precipitation. Both lumped and distributed models were tested, but only the spatially distributed ones provided reasonable estimates of runoff volumes. Model structures tested included multiplicative linear and exponential forms. Both seasonally varying and time independent land use coefficients were tested. The calibration and testing on the 7500 sq km Sont and Muna watersheds suggested that reliable forecasts can be made using the multiplicative linear model form utilizing a spatial separation of the watershed such that the precipitation and land use effects are relatively uniform within the subarea. Seasonal adjustment of the land use coefficients will further improve the overall accuracy of the water supply forecasts. (Baker-IVI)
W84-05346

CONDITIONS GOVERNING THE USE OF APPROXIMATIONS FOR THE SAINT-VENANT EQUATIONS FOR SHALLOW SURFACE WATER FLOW,
Institute of Hydrology, Wallingford (England).
J. H. Daluz Vieira.
Journal of Hydrology, Vol. 60, No. 1-4, p 43-58, January, 1983. 10 Fig, 6 Ref.

Descriptors: *Waves, *Overland flow, *Model studies, Mathematical equations, Saint-Venant Equations, Surface flow, Channels, Kinematic waves.

The propagation of shallow waves in open channel or overland flow can be described by the full Saint-Venant equations. The two parameters which govern these two equations are the Froude number and the kinematic wave number. An attempt is made to determine whether approximations of these two parameters can be used for certain values of these parameters. The solutions of the Saint-Venant equations are compared with those of the kinematic, diffusion and gravity wave approximations, for a range of constant Froude and kinematic wave numbers, with two different lower boundary conditions: critical flow, and zero depth gradient. Constant lateral inflow is assumed. (Baker-IVI)
W84-05348

MODELS OF STREAM BED TOPOGRAPHY AT THE REACH SCALE,
Sheffield Univ. (England). Dept. of Geography.
A. D. Knighton.
Journal of Hydrology, Vol. 60, No. 1-4, p 105-121, January, 1983. 4 Fig, 1 Tab, 35 Ref.

Descriptors: *Channels, *Topography, *Stream beds, Model studies, Energy, Meanders, Riffles.

A simple model of channel geometry is presented which focuses on the way that a single form variable may be autocorrelated with upstream values of the variable and which is amenable to analysis using time series methods. Stream bed topography at the local scale is the variable of interest. Bed height series were obtained for four stream lengths located at different positions along a mountain stream to test the hypothesis that, as control variables change partially, the form of the model will also change. The Box-Jenkins models describing the series are dominated by autoregressive terms and indicate a non-random variation of bed height. An increase in the order and parameter magnitude of the models is associated with an increase in discharge and a decrease in bed material size, suggesting that the structure of the model reflects the adjustability of the stream bed and, specifically, the extent of riffle-pool development, although channel gradients may be too high for a well-defined riffle-pool sequence to be developed. Changes in the parameter structure of the models describing the bed height series appear to reflect changes in the ability of the stream to adjust its local bed topography. As discharge increases and bed material size decreases, the magnitude of the autoregressive parameters and the order of the model increase. There is a corresponding change also in the extent to which the stream has developed a riffle-pool bed. Because the riffle-pool sequence has been associated with meander development and the way in which a stream consumes its energy, these parametric models may be useful indicators of the patterns of energy availabilty and utilization in natural streams. Although the sample is small, the analysis does suggest that even in a relatively short stream there are marked longitudinal variations in the adjustability of channel bed form. (Baker-IVI)
W84-05351

ASSESSMENT OF THE R-INDEX METHOD FOR CALCULATING STORMFLOW VOLUMES IN NATAL, SOUTH AFRICA,
Zululand Univ., Empangeni (South Africa). Hydrological Research Unit.
A. S. Hope.
Journal of Hydrology, Vol. 60, No. 1-4, p 143-155, January, 1983. 1 Fig, 4 Tab, 25 Ref.

Descriptors: *Storm runoff, *Catchment areas, Model studies, Simulation, Antecedent moisture, Antecedent rainfall, Natal, South Africa, R-index method, Precipitation.

The R-index method was developed to calculate stormflow volumes and peak discharge rates from small forested and wildland catchments, The possible adaptation of this method for calculating stormflow volumes from small catchments in Natal, South Africa was investigated. Following a description of the R-index method, procedures for testing the model on selected catchments in Natal are outlined. Initial flow rate and a seasonal variable are given as alternative indices for estimating antecedent moisture conditions for the R-index method, procedures which are unsuitable for the widespread use of this method in Natal. The R-index method, using initial flow rate as an input for antecendent moisture conditions, simulated stormflows accurately for the selected catchments in Natal. Similar stormflow producing mechanisms appear to operate in the eastern U.S.A. and Zululand resulting in similar model parameters for the two regions. The accuracy of this method for stormflow simulations in both regions indicates that the major variables responsible for stormflow production are well accounted for in the model. In catchments where the streams are non-perennial or intermittent, the initial flow rate is an unsuitable variable for representing antecedent moisture conditions as many stormflow events are preceded by zero flow. General similarity in parameter values may result in more accurate stormflow simulations than exact estimates of two parameters and a substantial deviation in the third. Antecedent rainfall is a good substitute for the initial flow rate as a measure of catchment moisture status and in some cases is as good or better than the initial flow rate for stormflow prediction. The total antecedent rainfall over 15 days appears to be the most suitable index of catchment moisture status for including in the R-index method for stormflow estimates in Natal. (Baker-IVI)
W84-05360

2F. Groundwater

SOLUTIONS FOR SOLUTE TRANSPORT IN AN UNCONFINED AQUIFER,
James Cook Univ. of North Queensland, Townsville (Australia).
V. Guvanasen, and R. E. Volker.
Journal of Hydrology, Vol. 58, No. 1-2, p 89-102, August, 1982. 6 Fig, 1 Tab, 20 Ref.

Descriptors: *Solute transport, *Unconfined aquifers, Aquifer management, Groundwater re-

charge, Numerical analysis, Mathematical studies, Flow characteristics, Flow, Recharge basin.

In unconfined aquifers with geohydrologically favorable conditions including sufficiently permeable strata between the ground surface and the water table, it is sometimes economical to artificially recharge by the method of basin infiltration. Two analytical solutions are presented for a problem of solute transport in transient flow in an unconfined aquifer. The source of the solute is a strip recharge basin, infinitely long and symmetrically placed in the middle of the aquifer which is bounded on either side by a constant-head drain. The governing equations are simplified so that they are amenable to solution by conventional analytical methods. The major assumption used is that the rise of the free surface above the initial saturated depth is much smaller than the initial saturated depth. The solutions are compared with available experimental data and results from numerical models and are shown to be useful provided the dimensionless recharge parameter is below a certain critical value. (Murphy-IVI)
W84-04841

EFFECT OF DISPERSION ON THE ESTABLISHMENT OF A PALEOCLIMATIC RECORD FROM GROUNDWATER,
Australian Atomic Energy Commission Research Establishment, Sutherland.
M. R. Davidson, and P. L. Airey.
Journal of Hydrology, Vol. 58, No. 1-2, p 131-147, August, 1982. 4 Fig, 28 Ref.

Descriptors: *Solute transport, *Groundwater, Mathematical models, Model studies, Climate, Paleoclimate, Dispersion, Isotope studies, Aquicludes.

A mathematical model is described which can account for the dispersion of solute in underground water over time scales exceeding 10000 yr. In its simplest form, the model postulates a diffusion limited exchange of material between flowing groundwater and the stationary water in the confining aquiclude, leading to the spreading of the solute in the mobile water and a consequent reduction in its concentration variability. The model is used to study the increasing attenuation with age of the perturbations in groundwater composition induced by paleoclimatic oscillations in the late Quaternary. Specific reference is made to noble-gas concentrations, stable-isotope ratios and chloride levels. The dispersion process described can significantly reduce the variability of solute concentrations within an aquifer to below that present in recharging water over time scales which depend on the aquifer and aquiclude thickness. The extent of dispersion predicted by the model is not sufficient to explain the observed reduction in variability of stable-isotope ratios in the very old groundwater of the Great Artesian Basin. The numerical solution described is both fast and reliable enabling the easy determination of the response of an aquifer-aquiclude system to an arbitrary input function from an arbitrary initial state. The technique may be used to extend the model to multiple-aquifer-aquiclude layers. (Baker-IVI)
W84-04843

234U-238U DISEQUILIBRIA AS AN AID TO THE HYDROLOGICAL STUDY OF THE JUDEA GROUP AQUIFER IN EASTERN JUDEA AND SAMARIA, ISRAEL,
Israel Development Co. Ltd., Tel-Aviv.
A. Rosenthal, and J. Kronfeld.
Journal of Hydrology, Vol. 58, No. 1-2, p 149-158, August, 1982. 4 Fig, 2 Tab, 7 Ref.

Descriptors: *Aquifers, *Uranium radioisotopes, *Israel, Groundwater, Confined aquifers, Geologic fractures, Springs, Geohydrology, Isotope studies.

Two distinct aquifers can be defined within the Judea Group aquifer on the basis of their uranium-isotope disequilibria. Twenty-six water samples were taken from representative deep-drilled wells and all of the major springs of the area under investigation. The springs that issue from the phreatic upper aquifer clearly exhibit lower U-234/U-238 activity ratios than does the deeper confined water mass. Where faulting allows for interconnection of the aquifers intermediate values are found. The isotopic values can be used to delineate regions were exploitation of the lower Cenomanian subaquifer will not reduce the output of the overlying spring, or conversely to delineate regions where reduction of the spring discharge may be expected. The difference in the activity ratios between the two aquifers under study is attributed to differences in intensity of chemical weathering and the rate of flushing that they experience. The upper phreatic aquifer is subjected to a more intense chemical attack aided by a continuously renewable oxygen supply. This aquifer undergoes strong changes in water levels and the uranium-bearing sites are exposed to frequent flushing following seasonal rainfall cycles. The lower aquifer is much less exposed to atmospheric weathering processes. The rate of discharge is much slower, and the water levels are, in the absence of artificial pumping, much more stable. (Baker-IVI)
W84-04844

ONE-DIMENSIONAL MODEL OF ARTIFICIAL RECHARGE OF A DUAL AQUIFER SYSTEM,
Water Research Centre, Marlow (England).
R. J. Cameron, and J. B. Joseph.
Journal of Hydrology, Vol. 58, No. 3/4, p 251-265, September, 1983. 8 Fig, 4 Tab, 8 Ref.

Descriptors: *Artificial recharge, *Aquifers, *Mathematical models, *England, Boreholes, Aquitards, London Basin, Permeability, Lea Valley, Cretaceous Chalk.

A one-dimensional model of artificial recharge through a borehole to an aquifer overlain by an aquitard has been developed. The model allows for movement of water into the aquitard from below. Piezometer data giving the pressure in the aquitard near to two recharge boreholes in the London Basin (England) have been analyzed using the model in order to establish the storage and the vertical and horizontal permeabilities of the aquitard. The changes in piezometric level recorded during recharge show clearly that there is resistance to the vertical movement of water in the Basal Sands. Mathematical modelling of the system has shown that: the permeability and storage coefficients of the Basal Sands are small; there is a real movement of water into the Basal Sands as a result of artificial recharge of the Chalk; the Bullhead Bed at the bottom of the Basal Sands provides no greater hydraulic resistance than the main body of the Basal Sands; water stored in the Basal Sands is readily available for abstraction through the Chalk; the Basal Sands are effectively homogeneous laterally over distances of a few hundreds of meters. The best fit simulations were made when the model incorporated high ratios of horizontal to vertical permeability. (Baker-IVI)
W84-04850

GROUNDWATER IN DECCAN BASALTS OF THE BETWA BASIN, INDIA,
Minerex Ltd., Dublin (Ireland).
H. R. Versey, and B. K. Singh.
Journal of Hydrology, Vol. 58, No. 3/4, p 279-306, September, 1982. 10 Fig, 2 Tab, 13 Ref.

Descriptors: *Groundwater, *Groundwater availability, *Deccan Basalts, *Betwa River basin, *India, Geohydrology, Geology, Geohydrologic units, Groundwater potential, Deep wells.

A survey from 1976 to 1980 of a part of the valley of the Betwa River, underlain mostly by basalt, was undertaken in order to determine: (1) what groundwater resources are available in the basin and how best they can be developed; and (2) what methodological criteria are important in undertaking future surveys in similar basalt areas. Jointing, resulting from cooling and from movement, is common in the upper part of each basalt flow while the original crust of the flow was itself broken and jointed. The joints were often filled subsequently either with clay produced by weathering or by mineralization from silica-and lime-rich groundwater. Where not obliterated they provide much of the permeability of the Deccan basalts, the rest being provided by the present-day weathering mantle. There is little continuity of water-bearing levels. The aquifers have transmissivities of 50-500 sq m/day but they are very local. The regional transmissivity is only 4 sq m/day. Storativity is thought to be 10 to the -5th power. If drilling is stopped at 60 m the yield expectation is 175 cu m/day per well; deeper drilling gives expectation of only 5 cu m/day per 10 m of drilling. These are averages: in fact of the thirty holes drilled, eight gave negligible yield; in five of the nine holes which met aquifers deeper than 60 m the water was unsuitable for irrigation. Because of poor recharge and low storativity the deep aquifers do not offer much replenishable yield. The shallow aquifer is a bit better and full development of its resources will provide 50 mm to be used between the end of one monsoon and the start of the next. Of the 50, 30 mm is presently lost to baseflow during September and October, immediately following the monsoon and before the winter crop is planted. With present agricultural practice this 30 mm will continue to run to waste and only the remaining 20 mm will be available for irrigation. Half of this is already pumped for open wells or from the rivers. (Murphy-IVI)
W84-04852

ISOTOPE HYDROLOGY OF THE GROUNDWATERS OF CENTRAL MEXICO,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
A. Issar, J. L. Quijano, J. R. Gat, and M. Castro.
Journal of Hydrology, Vol. 71, No. 3, p 201-224, March, 1984. 12 Fig, 1 Tab, 22 Ref.

Descriptors: *Isotope studies, *Geohydrology, *Mexico, Chemical composition, Chemical properties, Isotope fractionation, Hydrologic models, Groundwater level, Groundwater dating.

The environmental isotope (O-18, D = H-2) composition of the groundwaters of central Mexico can be divided into three distinctive groups: (1) groundwaters whose isotope composition fits the contemporary meteoric-water line with d = 10 0/00; these are from shallow aquifers, mainly in volcanic and alluvial rocks; (2) waters whose isotope data plot to the right of the meteoric-water line, describing a new meteoric-water line of d = 5-7 0/00; this group is made up of waters from the confined limestone aquifers which are of regional dimensions; (3) groundwaters with marked oxygen excess which emerge in regions of recent/subrecent volcanic activity and are geothermal in nature. The second group is considered to be of greater age, the isotopic composition being that of paleowaters. The third group's isotope composition reflects water-rock interactions and isotope fractionation which accompanies steam separation. In spite of some local peculiarities the water sources of central Mexico can be fitted to a general hydrogeological model, which is presented. (Murphy-IVI)
W84-04860

RELATIONSHIP OF SALINITY OF GROUNDWATER TO RECHARGE IN THE SOUTHERN KALAHARI DESERT,
Geological Survey of Israel, Jerusalem.
A. Arad.
Journal of Hydrology, Vol. 71, No. 3/4, p 225-238, March, 1984. 5 Fig, 1 Tab, 22 Ref.

Descriptors: *Salinity, *Saline-freshwater interfaces, *Groundwater recharge, *Kalahari Desert, Groundwater budget, Groundwater basins, Groundwater availability, Infiltration, Molopo River, Orange River, South Africa.

The semi-arid of the southern Kalahari Desert, between the Molopo River in the north and the Orange River in the south is considered an area of meager groundwater sources. Occurrences of modern groundwater in the Kalahari Formation aquifer, suggest current recharge taking place in the dry river channels, as well as through thin sand cover, where the pre-Kalahari erosional surface is shallow or exposed. In the pan belt of the western

part of the area studied, the Kalahari Formation seems to form a common aquifer with certain parts of the underlying Dwyka Formation. It is presumed that the large pans there, are superimposed on a pre-existing drainage system, dating back to a pre-Kalahari epoch. The highly concentrated brine in the Dwyka Formation in the pan belt is a shalow phenomenon, caused by insufficient flushing of the low-lying pans. Seasonal fluctuations in the pans force the brine up to where it undergoes evaporation, resulting in evaporites, which occasionally leach back to the ground. The occurrence of brines, however, does not prove that these are outlets of a basin which is recharged in the east and hence represent apparent salinity growth. It only suggests a dry period which followed the pre-Holocene high lake level and caused the brine formation. These brines will remain unflushed as long as the current climatic conditions prevail. (Murphy-IVI)
W84-04861

VERIFICATION OF LATERAL PERCOLATION LOSSES FROM IRRIGATED RICE FIELDS BY A NUMERICAL MODEL,
Land Resources Development Centre, Surbiton (England).
For primary bibliographic entry see Field 3F.
W84-04867

SOLUTION OF TRANSIENT FREE-SURFACE FLOW PROBLEMS IN POROUS MEDIA BY A FIXED-DOMAIN METHOD,
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
C. S. Lin, J. C. Bruch, Jr., J. M. Sloss, and V. Comincioli.
Journal of Hydrology, Vol. 71, No. 3-4, p 353-376, March, 1984. 6 Fig, 11 Ref. University of California project UCAL-WRC-W-607.

Descriptors: *Transient free-surface flow, *Porous media, *Fixed-domain method, Numerical models, Mathematical models, Mathematical equations, Baiocchi transformation, Hydraulic conductivity, Flow characteristics, Recharge, Groundwater movement, Flow discharge.

The study of flow through porous media has great significance in the development and management of water resources. Knowledge of the amount of seepage is essential for water conservation practice. The location of the free surface is needed for determining the safety zones in a contaminated groundwater system. The numerical model presented is the solution to the exact initial-boundary-value problems arising in recharge fluid flow through porous media having free surface. Since the problem is nonlinear and includes a moving boundary, a numerical solution is obtained by using a fixed-domain approach. The Baiocchi transformation and method are used to develop a boundary-value problem which is then solved by an iterative method of successive over-relaxation type. Transient free-surface seepage through a two-dimensional dam with accretion is presented as an example problem. The effects of hydraulic conductivity, specific storativity and accretion on the seepage flow are studied. Two modified cases are satisfactorily compared with published results. (Murphy-IVI)
W84-04868

PARTICLE SIZE DISTRIBUTION AND NATURAL COAGULATION IN LAKE ZURICH (PARTIKELGROSSENVERTEILUNG UND NATURLICHE KOAGULATION IM ZURICHSEE),
Institut fuer Gewaesserschutz und Wassertechnologie, Zurich (Switzerland).
G. K. Osman-Sigg, and W. Stumm.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 405-422, 1982. 12 Fig, 4 Tab, 12 Ref.

Descriptors: *Suspended sediments, *Particle size, *Lake Zurich, *Switzerland, *Coagulation, Sediment transport, Sedimentation, Lake sediments, Distribution, Colloids.

The particle size distribution in Lake Zurich shows always about the same form at every depth and during every season. A simple model consideration shows that there is a mechanism that transports the smallest particles faster to the sediments than the sedimentation rate alone can do it. Such a mechanism could be coagulation. Investigations on lake sediments and on collected, suspended particulate matter show that there are agglomerates of particles. Colloids occurring in nature such as clay minerals and metal oxides coagulate in filtrated lake water. The observations showed that the particle size distribution in Lake Zurich is determined by sedimentation and coagulation and that biological activities, such as algal blooms, have no effect. (Baker-IVI)
W84-04919

KENTUCKY BLUEGRASS GROWTH AND WATER USE UNDER DIFFERENT SOIL COMPACTION AND IRRIGATION REGIMES,
Kansas State Univ., Manhattan. Dept. of Horticulture.
For primary bibliographic entry see Field 3F.
W84-04993

TEMPERATURE ANOMALIES IN POROUS AQUIFERS DUE TO WARM- OR COLD WATER INFILTRATIONS (TEMPERATURANOMALIEN IN PORENGRUNDWASSERLEITERN ZUFOIGE WARM- ODER KALTWASSEREINLEITUNGEN),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
H. Kobus, T. Soll, and H. Mehlhorn.
Wasserwirtschaft, Vol. 73, No. 9, p 265-270, 1983. 6 Fig, 15 Ref.

Descriptors: *Aquifers, *Temperature, Infiltration, Temporal distribution, Aquifer discharge, Mathematical equations.

One-dimensional calculation methods are presented which provide an orientation aid to the planner in estimating the extent of temperature anomalies in aquifers. Temporal variations of infiltration temperature and discharge are discussed. The development of the temperature anomaly towards a quasi-steady final state is shown and illustrated by examples. (Author's abstract)
W84-05249

PUMPING TEST CARRIED OUT BY THE LANDESWASSERVERSORGUNG STUTTGART IN THE SO-CALLED EROLZHEIMER FELD (DER GROSSPUMPVERSUCH DES ZWECKVERBANDES LANDESWASSERVERSORGUNG IM EROLZHEIMER FELD-ILLERTAL),
Zweckverband Landeswasserversorgung, Stuttgart (Germany, F.R.).
H. Mehlhorn, and D. Flinspach.
Wasserwirtschaft, Vol. 73, No. 12, p 511-5116, December, 1983. 6 Fig, 9 Ref.

Descriptors: *Pumping tests, *Erolzheimer Feld, *West Gemany, *Iller River, Geohydrology, Mathematical models, Groundwater, Hydrologic models, Groundwater budget, Groundwater potential.

The so-called 'Erolzheimer Feld', a plain extending along the left bank of the river Iller, between the town of Memmingen and the community of Kirchberg, disposes of important groundwater resources which were investigated in detail during the winter months of 1979/80, when pumping tests with two vertical wells were carried out. The quantity of water delivered was almost 900 l/s on an average. Altogether, 10.5 million cu m of ground water were drawn. The following report describes the preparatory work and execution of the pumping tests, the test evaluation to determine the hydrogeological and hydrological parameters and the work with the numerical groundwater model. The effects of the pumping tests on the hydrologic system are shown. (Murphy-IVI)
W84-05268

GROUNDWATER FLOW SYSTEMS IN THE ARID CRYSTALLINE PROVINCE OF SOUTHERN SINAI,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
A. Issar, and D. Gilad.
Hydrological Sciences Journal, Vol. 27, No. 3, p 309-325, September, 1982. 12 Fig, 15 Ref.

Descriptors: *Geohydrology, *Arid-zone hydrology, *Sinai, *Groundwater movement, Remote sensing, Satellite technology, Elat Rift, Groundwater potential, Groundwater, Aquifers.

A hydrogeological research project was conducted in the arid crystalline province of the Southern Sinai. To gain a better understanding of regional groundwater flow patterns, Landsat images as well as air photos were used. Three main flow systems, were investigated. The flow system occurring along longitudinal regional crustal fractures with the direction parallel to the Gulf of Elat Rift; this system captures the flow in the main wadi beds draining eastwards. The flow system found in shallow fractured rocks, capturing the flow in small tributaries in the upper part of the drainage basin. The system of dikes governing the flow regime in wadi beds draining westwards. The preliminary estimate of the recharge into the fractured crystalline aquifers and the interconnected gravel bed aquifers is in the order of magnitude of 10-15% of the total precipitation. (Author's abstract)
W84-05289

SOME PROBLEMS RELATING TO GROUNDWATER BALANCE,
Tsukuba Univ., Ibaraki (Japan). Inst. of Geoscience.
I. Kayane.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 125-137, 1983. 9 Fig, 14 Tab.

Descriptors: *Groundwater, *Aquifer recharge, Japan, Nagaoka, Water supply, Irrigation, Snowmelt, Pumping, Water balance, River Shinano, Percolation, Rainfall.

The groundwater balance of the city of Nagaoka, Japan is presented in the form of a case study. At Nagaoka there are three features: in winter groundwater is ejected from pipes under the roads to melt freshly fallen snow; the river is hydraulically in contact with the aquifers; and the water table has remained quasi-stationary for the last 5 years despite the vast pumping program. The main sources of recharge are the River Shinano, deep percolation from irrigated fields, snowmelt in spring, and rainfall throughout the year. The water table was monitored using observation data from about 200 wells. During the irrigation period in August there was an inflow of groundwater, but groundwater resources were depleted in winter and spring by pumping for the snowmelting scheme. The evaluation and estimation of the components of the groundwater balance are discussed. Methods of measuring deep percolation either directly or indirectly are examined. (Baker-IVI)
W84-05302

NATURAL GROUNDWATER RECHARGE IN AN UPLAND AREA OF CENTRAL NORTH DAKOTA, U.S.A.,
North Dakota Univ., Grand Forks. Engineering Experiment Station.
B. W. Rehm, S. R. Morgan, and G. H. Groenewold.
Journal of Hydrology, Vol. 59, No. 3-4, p 293-314, November, 1982. 7 Fig, 3 Tab, 43 Ref. EPA grant R-803727 and R-805935, OWRT grant A-061-NDAK.

Descriptors: *Aquifer recharge, Groundwater, North Dakota, Permeability, Water table, Darcy equation, Seasonal variation, Snowmelt, Pecipitation, Evapotranspiration.

The magnitude of groundwater recharge to coal aquifers in a 150 sq km area in west-central North Dakota was determined using three separate approaches: the net water level rise in water table wells; calculations of the fluid flux between nested piezometers using the Darcy equation and measured values of hydraulic conductivity and vertical

gradients; and the evaluation of the inputs to and outputs from the coal aquifer using steady state control volume approach in which the aquifer was divided into semi-rectangular cells bounded by equipotential lines and flow lines. Evaluation of site hydrology and stable isotope data indicated that recharge was restricted in both time and place. Most recharge occurs in late spring when precipitation and stored winter snowmelt provide large quantities of water and evapotranspiration rates are negligible and in the fall after heavy rainfall events. Some recharge may occur during very heavy localized summer storms, but it is not considered volumetrically significant. Major permanent depressions on the site are a source of significant recharge. (Baker-IVI)
W84-05343

SOURCE OF WATER FROM THE THERMO-MINERAL SPRINGS OF LAKE KINNERET (ISRAEL),
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
A. Issar.
Journal of Hydrology, Vol. 60, No. 1-4, p 175-183, January, 1983. 3 Fig, 1 Tab, 9 Ref.

Descriptors: *Springs, *Aquifers, Salinity, Temperature, Lake Kinneret, Israel, Coastal plains, Rift Valley.

The chemical and isotopical composition of the thermomineral water emerging around Lake Kinneret is shown to be similar to that of the saline water found in deep oil-exploration wells in the Coastal Plain of Israel, and different from the water found near the Dead Sea. These findings rule out the hypothesis that Neogene or Pleistocene saline water which was formed in the Rift Valley and penetrated the aquifers is being pushed back into the Rift Valley. The mechanism to explain the resemblance to the Coastal Plain water seems to be that an ancient brine has filled most of the deep non-flushed aquifers of Israel and Jordan, probably in Cretaceous times, and is now pushed in a piston action model by paleo-meteoric water towards the Rift Valley. Thus, during its history the Rift Valley formed a base level and not a source of water. Only in the vicinity near the Dead Sea can one find limited zones where saline water penetrated under interface conditions when the specific weight of the water, due to its concentration, was above that of the hydraulic head of emerging springs. (Baker-IVI)
W84-05355

ENVIRONMENTAL TRITIUM AND RADIOCARBON STUDIES IN THE VEDAVATI RIVER BASIN, KARNATAKA AND ANDHRA PRADESH, INDIA,
National Geophysical Research Inst., Hyderabad (India).
B. S. Sukhija, and A. A. Rao.
Journal of Hydrology, Vol. 60, No. 1-4, p 185-196, January, 1983. 5 Fig, 1 Tab, 12 Ref.

Descriptors: *Aquifer recharge, Confined aquifers, Unconfined aquifers, Vedavati River, River basins, Aging, Groundwater, Isotope studies, Karnataka, Andhra Pradesh, India.

Environmental tritium and radiocarbon studies were made in the Vedavati river basin situated partly in Karnataka and partly in Andhra Pradesh, India. The determination of the general recharge condition of the water-bearing zones in the gnessic complex, granites and the Dharwar Group of metamorphic rocks where groundwater occurs under semi-unconfined to semi-confined conditions and at places under the water-table condition was undertaken. Groundwater recharge was relatively high at the western, southern, and eastern boundaries of the Vedavati river basin. Apparent radiocarbon ages range from modern to 4500 yr. An excellent correlation was found between the hydro-isochrons and groundwater recharge contours, and between groundwater ages and intensity and density of fractures. (Baker-IVI)
W84-05356

222-RN CONTENT OF GROUNDWATER IN STRATA OF THE PLIO-PLEISTOCENE OSAKA GROUP IN THE SENNAN AREA, JAPAN,
Kyoto Univ., Osaka (Japan). Research Reactor Inst.
M. Fukui, and K. Katsurayama.
Journal of Hydrology, Vol. 60, No. 1-4, p 197-207, January, 1983. 5 Fig, 6 Tab, 12 Ref.

Descriptors: *Groundwater, *Radon, Water analysis, Japan, Sennan area.

Studies were conducted on the 222-Rn content of groundwater to obtain knowledge of its distribution in the geosphere just below ground surface and below the depth of 100 m in the Osaka Group (Plio-Pleistocene). Samples analyzed from ten bore holes within 10 m depth below land surface showed that a sandy layer contained groundwater with consistent radon concentrations except for a few locations where the variations in the water level were large due to precipitation and/or the water level was within 2 m of ground surface. The average 222-Rn concentration in groundwater within 10 m of land surface was about equal to 1/3 to 3/5 of the highest concentration in groundwater from a well penetrating 100-200 m, 420 pCi/l. In shallow groundwater that mixed easily with precipitation and irrigation water, the radon contents were decreased by about 1/4 in comparison with the other concentrations. No sample analyzed exceeded 500 pCi/l. (Baker-IVI)
W84-05357

ISOTOPE HYDROLOGY STUDY OF THE KALAMOS ATTIKIS AND ASSOPOS RIVER-PLAIN AREAS IN GREECE,
Institute of Geology and Mineral Exploration, Athens (Greece).
G. Kallergis, and I. L. Leontiadis.
Journal of Hydrology, Vol. 60, No. 1-4, p 209-225, January, 1984. 7 Fig, 3 Tab, 22 Ref.

Descriptors: *Aquifer recharge, *Groundwater movement, *Greece, *Kalamos Attikis, *Assopos River, Isotope studies, Aging, River basins, Coastal plains, Springs, Karst hydrology.

Variations in the isotopic composition of water were used to define the mechanism of recharge of the Assopos riverplain and the Kalamos Attikis coastal brackish krast springs. The Kalamos springs are mainly recharged by the Parnis system, which are recharged at elevations greater than 570 m. The water of the Parnis system feeding the Kalamos springs passes east of Avlon and through Mavrosouvala. The average velocity is about 500-850 m/yr. Water like that of the Parnis system occurs below the Neogene aquifer in the central and western part of the Assopos riverplain also, but this part of the Parnis water reservoir appears inactive. The area of Mavrosouvala is the most convenient site for the recovery of the Parnis groundwater feeding the kalamos springs before its mixing with seawater. The water content of the groundwater reservoir, feeding the Kalamos springs is over 4.2 x 10 to the 9th power cu m, about 42 times the potential mean annual recharge. About 25% of this quantity is contained between Avlon and Mavrosouvala and 18% between Mavrosouvala and Kalamos. Local rain water is the main source of recharge to the Neogene aquifer of the Assopos riverplain. The surrounding hills, the river, and the Remma Botheza affect the recharge of a relatively narrow band along the boundary of the plain and along the river and the remma. In the central part of the Assopos riverplain the groundwater level is only a few meters below surface and its mean age is 19-35 yr, while in the central and western parts of the plain the groundwater is more than 20 m deep, its mean age being more than 100 yr. (Baker-IVI)
W84-05358

HYDROLOGY OF AUTOGENIC PERCOLATION SYSTEMS IN SOME TROPICAL KARST OUTCROPS, WEST MALAYSIA,
Saint David's Univ. Coll., Lampeter (Wales). Dept. of Geography.
J. Crowther.
Journal of Hydrology, Vol. 60, No. 1-4, p 227-242, January, 1983. 5 Fig, 2 Tab, 31 Ref.

Descriptors: *Karst hydrology, *Percolation, Malaysia, Tropical regions, Groundwater, Seepage, Setul Boundary Range, Topography, Limestone.

Flow regimes of underground seepages in three tower-karst outcrops and in the Setul Boundary Range, West Malaysia are reported. The autogenic percolation systems of the tower-karst hills and the Setul Boundary Range may be clearly distinguished. In the former, groundwater movement is mostly confined to vertical and near vertical rock fractures and there is little concentration of flow. In the uppermost 40 m of the tower karst outcrops groundwaters are chiefly of the diffuse type, but small conduits which transmit stormflow are also present. Many of these conduits appear to terminate at greater depths. Such closed conduits, which are drained by tight fractures at the base, act as reservoirs within the aquifer. The reservoirs are perhaps funnel-like in form and the water levels within them may remain fairly high. Under these circumstances, hydrostatic pressure is more strongly affected by longer-term variations in rainfall than by single storms. In consequence, the flow regimes of many seepages correlate most closely with rainfall in antecedent periods of 1-16 days or more, the length of the period being generally greater in the deeper percolation systems. Master conduits, which are continuous through the largest outcrops, display relatively small variations in discharge and are probably fed by diffuse percolation. The percolation system of the Setul Boundary Range is strongly influenced by the presence of near horizontal bedding plane fractures. These favor lateral groundwater movement and the development of integrated drainage networks. As a result underground seepages are more localized than in the tower karst outcrops and their discharges are appreciably higher and more responsive to short term variations in rainfall. The contrasted geohydrological properties of the limestones significantly affect karst landform development in the peninsula. Vertical groundwater movement in the tower karst limestones leads to the formation of deeply dissected meso- and macrotopographies, whereas lateral flow in the Setul limestones favors a relatively even spatial distribution of chemical denudation and the development of a more subdued terrain. (Baker-IVI)
W84-05359

DAMPENING OF FLUCTUATIONS IN GROUNDWATER TEMPERATURE BY HEAT EXCHANGE BETWEEN THE AQUIFER AND THE ADJACENT LAYERS,
Rijksinstituut voor Drinkwatervoorziening, Leidschendam (Netherlands).
G. J. M. Uffink.
Journal of Hydrology, Vol. 60, No. 1-4, p 311-328, January, 1983. 8 Fig, 1 Tab, 16 Ref.

Descriptors: *Groundwater, *Temperature, *Heat transfer, Energy, Conservation, Heat, Flow, Heat transport.

Heat storage in aquifers is attractive from the point of view of energy conservation. However, the influence on the chemical and microbiological composition of groundwater is insufficiently known. An understanding of the transport of heat in the aquifer is needed for planning field experiments. For this purpose several aspects of nonsteady and periodic heat transport are discussed, with special attention to the heat exchange between an aquifer and its adjacent layers. Using a relation between groundwater temperature and the retention time of the injected water an indication for the temperature distribution in nonsteady and periodic conditions may be found from the streamlines and the retention times. Due to the heat exchange between the aquifer and the adjacent layers a considerable dampening of temperature changes may take place. The Lauwerier assumption (constant temperature in the aquifer in vertical direction), however, overestimates the dampening. This assumption may ony be used for relatively thin aquifers with a thickness of 1 to 10 m. For a thick aquifer vertical heat conduction in the aqui-

fer has to be considered. As in the case of steady heat transport, the changes of temperature around an injection well can be expressed as a function of the retention time of the injected water. Hence, heat flow patterns can be found by the calculation of groundwater streamlines and retention times. (Baker-IVI)
W84-05364

MEASUREMENT OF THE SEEPAGE AREA OF WELLS (ZUR BEMESSUNG DER SICKERSTRECKE AM BRUNNEN),
Rostock Univ. (German D.R.).
G. Wertz.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 177-178, May, 1983. 3 Fig, 5 Ref.

Descriptors: *Well seepage, *Seepage, Seepage loss, Water table wells, Water level, Water level fluctuations, Water loss, Mathematical equations.

A knowledge of the size and effect of the seepage area at a well is necessary to determine the water table, especially near the well. The seepage area is in general terms an inconsistency in the water level and occurs in the event of an increase in permeability in the direction of flow. A mathematical equation for the calculation of the inconsistency is given, whereby it is expressed in terms of drainable pore volume and permeability. Mathematical equations are also given to calculate seepage area (= inconsistency) at the outer edge of the well filter under stationary conditions and to determine the water level line. Only two other sources give similar equations; these are reproduced here and considered the only other reliable methods of calculation. Finally, an equation to calculate in general terms the water level line taking filters and soil deposition into consideration is given. These equations can be used to determine seepage areas for horizontal water fittings as well as for the vertical well. It is clear that the seepage area is identical to the effective radius of the well or pipe in question. This method of calculation can also be used for non-stationary conditions. (Gish-IVI)
W85-04803

2G. Water In Soils

GREEN-AMPT INFILTRATION PARAMETERS FROM SOILS DATA,
Agricultural Research Service, Beltsville, MD.
W. J. Rawls, D. L. Brakensiek, and N. Miller.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p 62-70, January, 1983. 1 Fig, 2 Tab, 16 Ref.

Descriptors: *Infiltration, *Soil properties, Permeability coefficient, Porosity, Model studies, Soil horizons, Soil profiles, Mathematical equations.

An analysis made of about 5,000 soil horizons indicated that appropriate procedures for determining Green and Ampt infiltration parameters (effective porosity, wetting front capillary pressure, and hydraulic conductivity) could not be developed for order 5 soil surveys. However, for orders 1-4 soil surveys, the methods for determining the Green and Ampt parameters, ranked according to accuracy, are: fit the Brooks and Corey equation to measured water retention matric potential data and determine the Green and Ampt parameters from the Brooks and Corey parameters; fit the Brooks and Corey equation to published water retention matric potential data obtained from literature sources and determine the Green and Ampt parameters from the Brooks and Corey parameters; predict the moisture tension curve based on particle size distribution, organic matter, bulk density, and either 1/3 or 15 bar water content, or both, using the appropriate set of equations and then fit the Brooks and Corey equation to the water retention matric potential curve, predicting the Green and Ampt parameters from the Brooks and Corey parameters; estimate the parameters based on profile horizon and soil texture classes; estimate the parameters based on soil texture classes. (Baker-IVI)
W84-04823

HORIZONTAL ABSORPTION OF WATER BY SOILS WITH VARIABLE DIFFUSIVITY,
Thessaloniki Univ., Salonika (Greece). School of Technology.
P. K. Tolikas, C. D. Tzimopoulos, and D. K. Tolikas.
Journal of Hydrology, Vol. 58, No. 1-2, p 123-129, August, 1982. 2 Fig, 1 Tab, 6 Ref.

Descriptors: *Soil water, *Absorption, *Diffusivity, Mathematical equations, Soil properties, Permeability, Wettability, Soil profiles.

A simple approximate analytical solution is presented to the problem of horizontal absorption of water in unsaturated soils. The infinite-domain problem was reduced to a finite-domain problem, under the assumption of an abruptly terminating wetting front, defined as the inflection point of the water-content profile. This assumption is supported by both theory and experiment. A suitable expression for the diffusivity profile in the form of a polynomial was chosen. The choice of this expression was based on some qualitative considerations about the form of the exact solution. Four parameters appearing in the chosen diffusivity profile were defined through the boundary conditions and two integral relationships satisfying the water content balance-integral and the diffusivity balance-integral. Numerical results can be obtained through the very simple expressions for the position of the wetting front and the soil water diffusivity profile. Numerical results achieved are in excellent agreement with those obtained by earlier methods. Comparing the results based on the theory of this paper with earlier theories, a slight difference appears in the slope of the wetting front. The appearance of smaller slopes in the numerical results of the current paper, is rather closer to the exact solution as the equation is an exact relationship and is directly used in the evaluation of the soil water diffusivity profile. (Baker-IVI)
W84-04842

DETERMINING UNSATURATED HYDRAULIC CONDUCTIVITY OF SOIL DURING DRAINAGE UNDER A SMALL RING INFILTROMETER,
Hawaii Univ. at Hilo. Dept. of Soil Science.
L. R. Ahuja.
Journal of Hydrology, Vol. 58, No. 2, p 167-173, August, 1982. 2 Fig, 1 Tab, 9 Ref.

Descriptors: *Unsaturated hydraulic conductivity, *Soil water, *Small ring infiltrometer, Soil pressure, Soil water potential, Hydraulic conductivity, Unsaturated flow, Drainage, Drainage density, Tensiometer, Infiltrometers, Infiltration, Silty-clay loam soil, Measuring instruments.

Unsaturated hydraulic conductivity of soil has been determined in situ from tensiometric measurements during drainage following infiltration of a large quantity of water. Soil-water pressure measurements from a multiple-depth tensiometer installed at vertical axis of a small ring infiltrometer are theoretically not much affected by lateral flow. Such measurements during drainage in a silty-clay loam soil were compared with respect to the prevailing lateral hydraulic gradients around the axis when outer rings of different sizes were used during the preceding water application. Data from outer-ring diameter of 120 cm were free from lateral flow effects, as no lateral gradients were present within 38 cm of the vertical axis. The data from outer-ring diameters of 30 and 60 cm seemed to be somewhat affected when compared with a reference case of 120 cm outer ring. Unsaturated hydraulic conductivities calculated from these data tended to slightly increase with decrease in outer-ring diameter from 120 cm, but were within a factor of 2-3. The diameter of the outer ring used for wetting the soil before starting the drainage should not be less than 60 cm. An outer ring of 90-120 cm diameter would be preferable. One or more multiple-depth tensiometers at a radical location would provide a check on the average lateral gradients around the axis. (Murphy-IVI)
W84-04846

LONG-TERM INFILTROMETER STUDY IN SOUTHERN IDAHO, U.S.A.,
Utah State Univ., Logan. Watershed Science Unit.
G. F. Gifford.
Journal of Hydrology, Vol. 58, No. 3/4, p 367-374, September, 1984. 1 Fig, 4 Tab, 24 Ref.

Descriptors: *Infiltration, *Idaho, *Infiltrometers, Plowing, Grazing, Vegetation, Idaho, Measuring instruments, Sagebrush.

Nine years of infiltration measurements were made over a 12 yr period on a big sagebrush site in southern Idaho that was plowed and seeded in the fall of 1968. Following the plowing treatment there was a significant decline in infiltration rates which took place over a 2 or 3 year period. Grazing, which was started in late 1970, did not cause a further reduction in infiltration rates beyond that caused by the plowing. However, grazing did appear to eliminate seasonal trends in infiltration rates and recovery of infiltration rates to preplowing rates is impossible as long as grazing continues. Given the initial 1-2 yr decline in infiltration rates due to plowing and the 4-6 yr recovery pattern shown by the exclosures, it appears that complete recovery of infiltration rates due to the plowing treatment alone would take at least 6 yr, and perhaps longer. This recovery period assumes no grazing. Where a gross disturbance such as plowing has occurred prior to the start of grazing, the use of grazing impact models may be misleading. The major problem lies in target infiltration values used to project recovery from grazing under specific schemes. The impact of cover on infiltration rates is highly variable. The impact will vary with time within a simulated storm as well as with the season. (Baker-IVI)
W84-04857

MODIFIED HORTON'S INFILTRATION EQUATION,
Guelph Univ. (Ontario). School of Engineering.
S. C. Verma.
Journal of Hydrology, Vol. 58, No. 3/4, p 383-388, September, 1982. 1 Fig, 12 Ref.

Descriptors: *Infiltration capacity, *Mathematical equations, *Horton's formula, Rainfall, Storms, Soil water, Rainfall-runoff relationship, Sprinkler irrigation, Infiltration, Urban watersheds, Small watersheds.

Horton's formula of infiltration is modified to be applicable in variable rain situations when, for a part of the time, the rainfall rate is less than the potential infiltration rate of the soil. This type of analysis is more suitable to small compact watersheds that respond quickly to storm input. Urban and small agricultural watersheds may be successfully handled by this technique. In large watersheds because of large areal non-uniformity in the variables affecting infiltration, it is usually not possible to find a representative infiltration equation for the entire watershed, thus making this technique unsuitable for large watersheds. If the watershed is subdivided so that the homogeneity of land use and soil conditions on each sub-watershed allows the infiltration to be represented by a single equation, this technique promises to yield satisfactory results. The serious weakness of such models is their inability to account for the effects of crusting, cracking, air entrapment and soil moisture distribution in the soil profile. (Baker-IVI)
W84-04859

NUMERICAL SIMULATION OF SOIL-WATER FLOW DURING DRYING IN A NONHOMOGENEOUS SOIL,
Rissho Univ., Tokyo (Japan). Dept. of Geography.
M. Higuchi.
Journal of Hydrology, Vol. 71, No. 3/4, p 303-334, March, 1984. 16 Fig, 1 Tab, 30 Ref.

Descriptors: *Numerical simulation, *Simulation analysis, *Soil water flow, *Nonhomogeneous soil, Evapotranspiration, Soil water potential, Heat, Heat flow, Hydrodynamics, Mathematical models, Hydraulic models, Soil water.

Large temperature gradients are observed near the soil surface because of intense solar radiation. The

high-temperature zone propagates downward with decreasing intensity and with some time lags to deeper soil layers. In the same manner, when the soil surface is subject to both solar radiation and wind, increased evaporation occurs from the soil and a zone of upward flux is formed near the soil surface. This zone of upward flux may propagate to deeper soil layers. A numerical model of boundary layers between soil and atmosphere is developed, which simulates soil-water movement during drying in a nonhomogeneous bare soil. A modified and extended form of Philip and de Vries' equations for soil-water and heat flows is deduced in the present study. The results of numerical simulation are compared with the data obtained from field observations in a volcanic ash soil in Japan called Kanto loam. The computed profiles agree fairly well with those of the field observations for a simulated period of 35 hr., following rain. The results are summarized as follows: directions of total moisture fluxes are upward above a depth of 35 cm; upward total moisture fluxes appear to decrease with depth from the soil surface to 35 cm; directions of total moisture fluxes are always downward below 35 cm; isothermal liquid fluxes contribute much to the total moisture fluxes in all stages of the computation at every depth; isothermal vapor fluxes are negligible; thermal moisture fluxes are negligible below a depth of 30 cm, where diurnal soil temperature variations are quickly damped; directions of thermal moisture fluxes appear downward in the daytime and upward at night; magnitudes of thermal liquid fluxes are larger than those of thermal vapor fluxes. (Murphy-IVI)
W84-04866

DECAY OF A DISTURBED FREE SURFACE IN A LAYERED POROUS MEDIUM,
Oslo Univ. (Norway). Dept. of Mechanics.
P. A. Tyvand.
Journal of Hydrology, Vol. 71, No. 3/4, p 377-382, March, 1984. 2 Fig, 3 Ref.

Descriptors: *Porous media, *Free surfaces, Gravitational water, Decay rate, Flow, Mathematical equations, Permeability, Fluid mechanics.

The gravitational decay of a free surface of fluid within a porous medium is studied theoretically. The porous medium consists of two superimposed horizontal layers of different permeabilities, resting on an impermeable bottom. A formula for the decay rate is found valid for small amplitudes of disturbance. Some general trends were deduced from the findings. A disturbance never penetrates significantly into a depth larger than its own wavelength, so a layering at a larger depth is beyond the reach of the disturbance, and may be disregarded. But a layering within this reach may be of great importance. The most important layer is that of maximum permeability. If this happens to be the top layer, the decay rate is usually of the same order of magnitude as if the permeability of the other layers is neglected. But if a layer below the surface has maximum permeability, it may drastically increase the decay rate compared to that of the uppermost layer alone. This is particularly important for disturbances of long wavelengths, and has hydrological relevance to long-range levelling of a groundwater table. (Baker-IVI)
W84-04869

PROFILES OF BROMIDE AND INCREASED SOIL MOISTURE AFTER INFILTRATION INTO SOILS WITH MACROPORES,
Science and Education Administration, Coshocton, OH. North Appalachian Experimental Watershed.
P. F. Germann, W. M. Edwards, and L. B. Owens.
Soil Science Society of America Journal, Vol. 48, No. 2, p 237-244, March-April, 1984. 8 Fig, 6 Tab, 31 Ref.

Descriptors: *Hydraulic profiles, *Bromide, *Soil water, *Infiltration, *Macropores, Particle size, Hydraulic permeability, Soil water potential, Soil profiles.

The purpose of this study was to investigate bromide and water distributions in soils as the result of macropore structure and sprinkling rate. Water was found to have moved laterally from the macropores into the soil matrix. It also has moved deeper into the soil with higher macroporosity and when applied at higher rates, as was indicated by bromide tracer profiles. Evidence is presented that the soil volume measured with a double tube gamma-ray probe was too small to follow the wetting process completely when macropores contributed to flow. A parameter, derived from the bromide profiles, can be used to characterize the hydraulic importance of macroporosity, based upon a simple approach to water flow along macropores. (Author's abstract)
W84-04871

FLUX-CONCENTRATION RELATION-BASED SOLUTION OF CONSTANT-FLUX INFILTRATION EQUATION: I. INFILTRATION INTO NONUNIFORM INITIAL MOISTURE PROFILES,
Centre National de la Recherche Scientifique, Grenoble (France). Inst. de Mecanique de Grenoble.
J. F. Boulier, J. Touma, and M. Vauclin.
Soil Science Society of America Journal, Vol. 48, No. 2, p 245-251, March-April, 1984. 7 Fig, 22 Ref.

Descriptors: *Infiltration equation, *Moisture profiles, *Infiltration, Ponding, Permeability coefficient, Richards' equation, Gamma ray, Numerical analysis.

The quasi-analytical solution of the infiltration equation based on the flux-concentration relation for constant flux condition and initially uniform water content profile is extended here to nonuniform moisture profiles for fluxes either smaller or greater than the saturated hydraulic conductivity. In the latter case, the solution is developed for the postponding stage. The measured flux-concentration relation is well-approximated and no significant time dependence can be observed. The quasi-analytical solution is then successfully compared with both laboratory experiments performed on a sandy soil column and numerical solution of the Richards equation for the nonponding, prepondings, and postponding stages of infiltration. (Murphy-IVI)
W84-04872

STEADY INFILTRATION FROM CIRCULAR CYLINDRICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
J. R. Philip.
Soil Science Society of America Journal, Vol. 48, No. 2, p 270-278, March-April, 1984. 10 Fig, 1 Tab, 28 Ref.

Descriptors: *Steady infiltration, *Circular cylindrical cavities, *Cavitation, Infiltration, Infiltration rate, Infiltration coefficient, Gravity flow, Mathematical equations, Water potential.

The problem of quasilinearized steady infiltration from circular cylindrical cavities, with the moisture potential fixed at the cavity surface, is solved exactly. Solutions are presented numerically and graphically for values of the dimensionless cavity radius, Ro, ranging from 0.01 to 10. The dependence on Ro of the average infiltration rate around the cavity surface, and of the distributions of moisture content and potential, are examined. As Ro increases, the effects of gravity on the phenomenon increasingly dominate those of capillarity. Gravity very strongly distorts the moisture distributions from the symmetry produced by capillarity alone: for Ro as small as 0.01, the depth of the effectively wetted region exceeds 250 times its horizontal width on the cavity center line; and the ratio increases rapidly with Ro, exceeding 50,000 for Ro = 5. An earlier small Ro approximation proves useful only for Ro < or = 0.2. The cavity flow, evaluated by the present analysis, may be combined with the line source solution to give approximate results useful for the region deeper than 50 radii below the cavity. (Author's abstract)
W84-04876

DIVISION S-6-SOIL AND WATER MANAGEMENT AND CONSERVATION; TEMPERATURE AND MOISTURE REGIMES IN SOILS MULCHED WITH TRANSPARENT POLYETHYLENE,
Hebrew Univ., Rehovoth (Israel). Faculty of Agriculture.
Y. Mahrer, O. Naot, E. Rawitz, and J. Katan.
Soil Science Society of America Journal, Vol. 48, No. 2, p 362-367, March-April, 1984. 7 Fig, 28 Ref.

Descriptors: *Moisture profiles, *Soil temperature, *Soil water management, *Soil water conservation, Mulches, Polyethylene, Hydraulic models, Microclimate, Soil water potential, Rehovot sand soil, Clay soil.

Solar heating of soils by mulching (tarping) with transparent polyethylene is widely used in agriculture, for heating soil during cool seasons. A numerical one-dimensional model was developed in order to study the effect of soil mulching with transparent polyethylene film upon the soil moisture and temperature regimes. Environmental conditions, soil physical characteristics, and optical properties of the cover are considered. Calculated moisture and temperature profiles were compared with observed ones in experimental field plots. It was shown that soil moisture and temperature distributions are significantly influenced by the polyethylene mulch. The numerical model accurately predicts the soil moisture and temperature regimes in two tested soils. In both a Rehovot sand soil and a light clay soil, experimental and calculated results showed that the temperature maxima of the soil increase with increasing soil moisture content. In the light clay soil both the experimental and numerical results showed that the tarping of the soil with transparent polyethylene caused a significant increase in soil moisture in the upper soil layer. At close to air-dry moisture content, the maximum temperature of the light clay soil indicated a much higher value than the wettest mulched plot of the same soil. Physically based explanations are given for the measured and computed results. (Murphy-IVI)
W84-04877

FIELD SYSTEM FOR AUTOMATICALLY MEASURING SOIL WATER POTENTIAL,
Alabama Agricultural Experiment Station, Auburn.
F. L. Long.
Soil Science, Vol. 137, No. 4, p 227-230, April, 1984. 2 Fig, 12 Ref.

Descriptors: *Soil water potential, *Measuring instruments, *Computers, Automation, Water potentials, Soil water, Electrical equipment, Tensiometers, Dataloggers.

A system is described which will automatically read soil tensiometers. The system uses a vacuum transducer on each tensiometer whose output voltage varies linearly with the amount of tension in the tensiometer. A datalogger is programmed to scan the transducers at selected intervals and record the information on cassette tape. The information is then transferred to a large computer for calculations and plotting of soil water potential with time. The system is battery operated, weatherproof, and suitable for use under field conditions. The datalogger is programmable to read the tensiometers at selected intervals, proper intervals depending on the objective of the study. The cost of the datalogger, including the interface, is about $8000. The cost of the transducers is about $90 each. The cost of tensiometers varies with length, but the average is about $30 each, which consists of the body, cap, and sensing tip. The cost of a system similar to the one described, consisting of datalogger, interface, tensiometers, transducers, wiring, etc., would total about $15,000. The increased accuracy obtainable with this system and the ability to ascertain small changes in soil water potential as a result of environmental changes should be considered. (Baker-IVI)
W84-04880

SOIL CHEMICAL AND PHYSICAL EFFECTS ON SPATIAL VARIABILITY OF HYDRAULIC CONDUCTIVITY,

Cornell Univ. Agricultural Experiment Station, Ithaca, NY. Dept. of Agronomy.
R. J. Wagenet, R. E. Knighton, and E. Bressler.
Soil Science, Vol. 137, No. 4, p 252-262, April, 1984. 2 Fig, 6 Tab, 12 Ref.

Descriptors: *Soil chemistry, *Soil physical properties, *Spatial distribution, *Permeability coefficient, Salinity, Soil texture, Mathematical studies, Linear regression, Correlation analysis, Soil water, Soil water potential, Kidman sandy loam.

The influence of spatial variation in soil salinity and texture upon the spatial variability in hydraulic conductivity of a Kidman sandy loam soil was determined using a statistical technique based on linear regression and correlation analysis. Field-measured values of Ko and beta were obtained by an approximate technique for estimating soil hydraulic properties. Soil samples were analyzed for EC, SAR, and percentages of sand, silt, and clay. The variations in EC and percentage of sand were chosen as most influencing Ko and beta. The variations in EC explained only 19 and 7% of the variation in Ko and beta, respectively, and the percentage of sand explained about 3 and 15% of the variation in the same two parameters. Unspecified effects were responsible for about 75% of the variation in both Ko and beta, suggesting that measurement methods or assumptions in developing K(theta) were partially responsible. (Murphy-IVI)
W84-04881

IN SITU DETERMINATION OF HYDRAULIC CONDUCTIVITY IN THE VADOSE ZONE USING BOREHOLE INFILTRATION TESTS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
D. B. Stephens, S. P. Neuman, S. Tyler, K. Larnert, and D. Watson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84 181081, Price codes: A09 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute Technical Report No. 180, Las Cruces, March, 1984. 174 p, 62 Fig, 13 Tab, 48 Ref.

Descriptors: *Hydraulic conductivity, *Infiltration, Borehole, Permeameter, Capillary conductivity, Carbon dioxide.

Predicting the rate of water movement above a water table is a crucial problem in hazardous and radioactive waste disposal, in the design of dams, and in the irrigation and drainage of agricultural land. Hydraulic conductivity, the key soil characteristic governing the rate of water movement, was determined in the field using constant head borehold infiltration tests. Earlier results of numerical simulations of the saturated-unsaturated flow process were verified; these indicate that only a finite zone of soil immediately surrounding the borehole is nearly saturated. Carbon dioxide injected into the borehole prior to water infiltration is an effective means to reduce the amount of entrapped air and reduce the water volume required to complete a test. New empirical solutions were developed to account for capillary effects. The borehole test results generally compared favorably with other field techniques which are restricted in application to the near surface, and also with laboratory permeameter experiments on Shelby tube samples. Laboratory permeameter experiments on small ring samples (100cc) produced consistently greater values of saturated hydraulic conductivity than other methods.
W84-04884

TOTAL RESISTANCE TO WATER FLOW IN FIELD SOYBEANS: II. LIMITING SOIL MOISTURE,
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2I.
W84-04977

SALT DISTRIBUTION AND WATER CONSUMPTION FROM A WATER TABLE WITH AND WITHOUT A CROP,
Iowa State Univ., Ames. Dept. of Agronomy.
H. H. Saleh, and F. R. Troeh.
Agronomy Journal, Vol. 74, No. 2, p 321-324, March-April, 1982. 2 Fig, 4 Tab, 10 Ref.

Descriptors: *Salinization, *Saline soils, *Water table, *Water use, Sudangrass, Groundwater, Saline water, Crop production.

The upward movement of saline groundwater and its subsequent evaporation and transpiration are important factors in soil salinity. The permanence of irrigation agriculture requires that soil salinity be controlled. The soil salinization process was quantified and related to soil depth, cropping, and water table variables. Data were gathered by measuring the upward movement of water and salt from simulated groundwater. The work was done with 30-cm square soil columns 50 and 75-cm tall that were suspended in trays of artificial groundwater, located in a greenhouse to create an arid environment. Low salinity groundwater containing 0.23% salt (electrical conductivity 4 mmhos/cm) and high salinity groundwater containing 0.68% salt (electrical conductivity 11 mmhos/cm) were used. Sudangrass (Sorghum sudanense) was grown on half of the columns and the others were fallowed. Sudangrass production ranged from 16 g of dry matter per 50-cm column with high salinity groundwater to 37 g per 75-cm column with low salinity groundwater. Water consumption was increased by the shallower depth to groundwater, by the less saline groundwater and by the presence of a crop. The crop had little effect on the salt concentration at the moist surface of the 50-cm columns but reduced the salt accumulation at the already drier and less salty surfaces of the taller columns. Salt accumulation in the root zone was increased by the presence of a crop. (Moore-IVI)
W84-04980

SOIL AVAILABLE WATER AS INFLUENCED BY LANDSCAPE POSITION AND ASPECT,
Nebraska Univ.-Lincoln. Dept. of Agronomy.
A. Y. Hanna, P. W. Harlan, and D. T. Lewis.
Agronomy Journal, Vol. 74, No. 6, p 999-1004, November-December, 1982. 3 Fig, 5 Tab, 19 Ref.

Descriptors: *Slope, *Aspect, *Available water, *Nebraska, Soil water, Dryland farming, Water storage, Topography.

In dryland farming, stored soil water is an essential source of water for crop production. The amount of water available for storage and crop use in a particular soil in hillslope topography is affected by its position on the landscape. The effect of slope aspect and position on soil water and its changes throughout the year in dryland farming were studied in southeast Nebraska. North, south, and east-facing slopes of Wymore silty clay loam (Aquic Argiudolls fine, montmorillonitic mesic) were selected for study. Four positions on each slope including summit, shoulder, backslope, and footslope were identified. Water content of the soil from 0 to 150 cm depth in 30 cm increments was measured weekly by neutron scattering for 2 years. Daily precipitation was recorded. Twenty percent more water was available in soils on the north-facing slope than in soils on the south-facing slope at planting and throughout the year. Soils on the east-facing slope were the driest. They contained 50% less available water than did those on the north-facing slope. Within slope positions, soils on the footslopes and backslopes contained an average of 4 cm more available water than soils on the summits and shoulders. Soil water sampling at planting time for crop management and yield prediction models should be done according to slope position. (Author's abstract)
W84-04996

EFFECT OF LANDSCAPE POSITION AND ASPECT ON SOIL WATER RECHARGE,
Nebraska Univ.-Lincoln. Dept. of Agronomy.
A. Y. Hanna, P. W. Harlan, and D. T. Lewis.
Agronomy Journal, Vol. 75, No. 1, p 57-60, January-February, 1983. 1 Fig, 5 Tab, 13 Ref.

Descriptors: *Slope, *Aspect, *Soil water recharge, *Nebraska, Dryland farming, Water storage, Seasonal variation, Available water, Rainfall.

The effect of landscape position and slope aspect on soil water recharge under dryland farming was studied in southeast Nebraska. North, south, and east-facing slopes of Wymore silty clay loam (fine, montmorillonitic, mesic Aquic Argiudoll) were selected. Four positions were identified on each slope, namely, summit, shoulder, backslope, and footslope. Water content of the soil from 0 to 150 cm depth in 30 cm increments were measured weekly by neutron probe for 2 years. Daily precipitation was recorded. Soils of the north-facing slope were 10% less efficient in recharge of available water than soils on south- and east-facing slopes during all recharge periods. Soils on footslopes were 6 to 8% more efficient than other positions throughout the year. Water storage efficiency of the soil appeared to be higher in fall than in spring. Available water recharge was 9% more efficient during the fall than during the winter-spring period in all soils regardless of slope aspects and positions. High correlation coefficients (r) existed when soil available water was related to rainfall in either fall or spring recharge period. (Author's abstract)
W84-04998

IRRIGATION SCHEDULING I: CROP AND SOIL PARAMETERS,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 3F.
W84-05005

IRRIGATION SCHEDULING II: SIMPLE, LOW COST TECHNIQUES,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 3F.
W84-05006

IN SITU DETERMINATION OF THE HYDRODYNAMIC DISPERSION COEFFICIENT AND ITS CORRELATION UNDER LABORATORY AND FIELD CONDITIONS,
Central Soil Salinity Research Inst., Karnal (India).
R. K. Batta, and V. V. N. Murty.
Journal of Hydrology, Vol. 59, No. 1-2, p 139-147, October, 1982. 5 Fig, 3 Tab, 4 Ref.

Descriptors: *Hydrodynamic dispersion, *Soil properties, Dispersion, Soil water, Solute transport.

Determination of the hydrodynamic dispersion coefficient is often done in the laboratory, using columns of artificially-packed disturbed soil. Disturbed soils and undisturbed natural soils exhibit a marked difference in their behavior because differences in bulk densities, water retention and infiltration characteristics alter the value of the dispersion coefficient. Experiments were conducted on undisturbed and disturbed samples to find the effect of medium disturbance on the hydrodynamic dispersion coefficient under laboratory and field conditions. A method to determine the dispersion coefficient uses finite differences; the values obtained with this method were found to compare favorably with other existing methods. Disturbance of a sandy loam caused a reduction of the dispersion coefficient to approximately 0.6-0.8 of its in situ value. The dispersion coefficients for undisturbed samples for different sites vary significantly (range 0.0640-0.0799 sq cm/min) while for the disturbed samples the variation is small (0.0470-0.0511 sq cm/min); this may be attributed to better control of variables in the laboratory than in field experiments. (Moore-IVI)
W84-05131

OPERATIONAL SIGNIFICANCE OF THE CONTINUUM HYPOTHESIS IN THE THEORY OF WATER MOVEMENT THROUGH SOILS AND AQUIFERS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
P. Baveye, and G. Sposito.

Water Resources Research, Vol. 20, No. 5, p 521-530, May, 1984. 2 Fig, 48 Ref. National Science Foundation Grant CEE 79-20778.

Descriptors: *Soil water, *Mathematical equations, Water transport, Porosity, Soil properties.

The operational meaning of the representative elementary volume concept (REV, on which current foundational theories of water movement through porous media are based, is critically analyzed. The concept of REV has been developed in a number of different rationalizations, but most of them take advantage of an assumed indifference property and limit their discussion to the invariance property as applied, for example, to the mass density of some constituent or to the porosity of the medium - either soil or aquifer material. Possibly because of its broad intuitive appeal and obvious connection with continuum hypothesis, the concept of the REV seldom has been examined critically. The lack of experimental verification, and perhaps, even of the possibility of experimental verification, of the hypothetical behavior illustrated by example casts serious doubt on the existence of the spatial invariance property of the REV for real porous media. A similar concern can be expressed for the time-invariance property. Such questions can be extended to its assumed indifference property as well. It is concluded that the REV concept as applied to real porous media is both unnecessarily restrictive and experimentally unverifiable. In its place a relativist concept is proposed in which macroscopic physical variables are defined as convolution products of microscopic properties of a porous medium with weighting functions that represent the appropriate measuring instruments. The effects of resolution and precision differences among experimental measuring devices can be incorporated naturally within the relativist concept but are excluded a priori in the REV concept. The relativist point of view has a clear operational meaning and extends theoretical validity to all local measurements made on porous media. It is sufficient mathematically to derive conventional macroscopic balance equations for mass and linear momentum as well as a differential equation for the isothermal transport of water through an unsaturated, anisotropic, deformable soil or aquifer. (Baker-IVI)
W84-05326

SURFACE INFILTRATION IN SALT MARSHES: THEORY, MEASUREMENT, AND BIOGEOCHEMICAL IMPLICATIONS,
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab. for Water Resources and Hydrodynamics.
H. F. Hemond, W. K. Nuttle, R. W. Burke, and K. D. Stolzenbach.
Water Resources Research, Vol. 20, No. 5, p 591-600, May, 1984. 10 Fig, 25 Ref. NOAA, Dept. of Commerce grant 04-7-158-44079.

Descriptors: *Infiltration, *Model studies, *Salt marshes, Tidal effects, Flooding.

An analysis of surface infiltration resulting from tidal flooding in a water saturated salt marsh is presented. The concepts related to a saturated compressible soil are used to fomulate a theoretical model for infiltration based on conventional relationships between water movement, pore pressure, and water storage. Through observations of subsurface piezometric head, an estimate of the magnitude of infiltration due to tidal flooding in a salt marsh is obtained. Finally, direct seepage meter measurements of water movement across the peat surface are presented. Implications for marsh ecological processes are briefly discussed. (Baker-IVI)
W84-05332

MOLECULAR DYNAMICS AND STATISTICAL MECHANICS OF WATER NEAR AN UNCHARGED SILICATE SURFACE,
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
D. J. Mulla, J. H. Cushman, and P. F. Low.
Water Resources Research, Vol. 20, No. 5, p 619-628, May, 1984. 12 Fig, 74 Ref.

Descriptors: *Molecular structure, *Solute transport, Colloids, Porosity, Swelling, Clay, Silicates, Mathematical equations, Transport, Saturated soils, Unsaturated soils, Soil properties, Vicinal water.

The mechanics that lead to clay swelling and the range of perturbation in vicinal water structure that may affect diffusion on clay surfaces and dispersion in clay-water systems are investigated. Statistical mechanics were used to interpret position and velocity trajectories computed in the molecular dynamics simulation. The results of the simulation indicate that the vicinal water differs substantially from bulk water over appreciable distances for the static orientation of molecular dipole moments and the rate of relaxation of these moments and substantially over smaller distances for hydrogen bonding patterns and the rate of self-diffusion. No significant differences between the radial distribution functions of vicinal and bulk water are evident. Because vicinal water may be perturbed to large distances from a clay surface, great care must be taken in deriving transport equations in saturated and unsaturated media which are high in clay. It would appear that a satisfactory derivation of the solute transport equations in systems high in colloids and having low water content does not exist. (Baker-IVI)
W84-05334

ASPECTS OF QUASILINEAR INFILTRATION FROM SURFACE SOURCES, ESPECIALLY THE CASE ALPHA = 0,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
J. R. Philip.
Water Resources Research, Vol. 20, No. 5, p 633-635, May, 1984. 8 Ref.

Descriptors: *Infiltration, *Mathematical equations, Flow, Unsaturated soils, Saturated soils.

A number of issues are treated concerning the quasilinear analysis of steady two-and three-dimensional flows in homogeneous unsaturated soils. These issues are of general significance, though they bear specifically on three papers (Batu, V., and W. R. Gardner, Soil, Sci. Soc. Am. J., Vol. 42, p. 18-22, 1978; Batu, V., J. Irrig. Drain. Div. Am. Soc. Civ. Eng., Vol. 105(IR3), 233-245, 1979; and Batu, V., Flow Net for Unsaturated Infiltration from Periodic Strip Sources, Water Resour. Res., Vol. 16, p 284-288, 1980) which give a misleading picture of the mathematical and physical meaning of the quasilinear analysis in the case alpha = 0 and of the connection between unsaturated and saturated flows. These papers assert that putting alpha = 0 in quasilinear solutions for the stream function gives solutions for saturated flows. In fact, putting alpha = 0 yields the precisely opposite case of purely capillary driven unsaturated flows. The argument of the papers is that for alpha = 0 the quasilinear equation for the stream function is reduced to Laplace's equation, which is obeyed by the stream function for saturated flows. The kinematics of all two-dimensional solenoidal irrotational flows is, however, such that their stream functions obey Laplace's equation, and the physical meaning, and indeed the physical existence, of any flow can be determined only from supplementary dynamic information about the velocity potential. (Baker-IVI)
W84-05336

WETTING FRONT ANALYSIS OF THE NON-LINEAR DIFFUSION EQUATION,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
J.-Y. Parlange, I. G. Lisle, S. N. Prasad, and M. J. M. Romkens.
Water Resources Research, Vol. 20, No. 5, p 636-638, May, 1984. 1 Tab, 9 Ref.

Descriptors: *Wetting, *Mathematical equations, Nonlinear diffusion equation, Soil water, Perturbation, Sorption.

A perturbation procedure for the solution of the nonlinear diffusion equation is presented. The procedure yields water content as a function of the distance to the wetting front. The result is in agreement with earlier predictions of wetting front position and sorptivity using an optimal technique. The approach of Prasad and Romkens (Water Resour. Res., Vol. 18, p 1022-1028, 1982) is modified to apply to cases with rapidly increasing diffusivity near saturation. The main modification lies in the use of an integral expression in the series expansion around the wetting front. The solution yields the same result for the position of the wetting front and sorptivity as that obtained by optimization. The accuracy of the results is illustrated by comparison with an exact solution. (Baker-IVI)
W84-05337

ANALYTICAL RESULTS FOR PREDICTION OF VARIABLE RAINFALL INFILTRATION,
Colorado State Univ., Fort Collins. Engineering Research Center.
H. J. Morel-Seytoux.
Journal of Hydrology, Vol. 59, No. 3-4, p 209-230, November, 1982. 3 Fig, 8 Ref. National Science Foundation grant ENG-7924120.

Descriptors: *Soil water, *Infiltration, Unsaturated soils, Mathematical equations, Boundary conditions, Rainfall, Permeability, Ponding.

The basic equations that govern water movement in unsaturated soils are presented for a boundary condition of variable rainfall rate at the soil surface. In particular, a differential equation for the water content at the soil surface is derived. Solutions are then obtained for the time evolution of water content at the soil surface assuming a power law form for the relative permeability to water as a function of normalized water content. Ponding time formulae are obtained and compared with other previously published relations. Water content profiles are also obtained and their shapes are displayed graphically for the case of an exponent of 2 in the power law form of the relative permeability to water for a constant rainfall rate. Formulae are also derived for the situation of a variable rainfall pattern. A methodology for the coupling of the analytical procedures with an implicit numerical solution of the water content at the soil surface is suggested as a cost effective alternative to the strict numerical solution of the partial differential equation that governs the water content profile evolution. Postponding infiltration formulae and water content profile equations are also provided. The results of the study are well suited for incorporation in current watershed models. The approximations involved in the derivations are of little consequence as the essential nonlinear character of the equations was preserved and because the various parameters will in practice be calibrated on a series of historical observations. (Baker-IVI)
W84-05338

USE OF NATURAL TRACERS AS INDICATORS OF SOIL-WATER MOVEMENT IN A TEMPERATE SEMI-ARID REGION,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
G. B. Allison, and M. W. Hughes.
Journal of Hydrology, Vol. 60, No. 1-4, p 157-173, January, 1983. 1 Tab, 8 Fig, 33 Ref.

Descriptors: *Soil water, *Drainage, Eucalyptus trees, Wheat, Semiarid lands, Australia, Roots, Evaporation, Chlorides.

A determination was made of the mechanism and amount of water moving through the soil beneath both native Eucalyptus scrub, known as mallee, and cleared, but cropped sites. The trees are characterized by an enlarged lignotuber beneath the soil surface from which several stems rise, giving the trees a coppiced appearance. The stems are branched sparingly and leaves occur only at the end of the branches. A change in land use from Eucalyptus scrub to wheat has caused considerable change in the mechanism of the movement of soil water and the amount of deep drainage. Chloride concentrations of soil water have been used to show the mean annual amount of deep drainage increases from less than 0.1 to about 3 mm/yr following clearing of the native vegetation. Chloride concentrations showed a peak in soil water of

about 11,000 g/cu m at a depth between 4 and 5 m beneath the cropped area. Beneath this depth concentrations fall slowly to about 9000 g/cu m at 12 m. The concentration of environmental tritium in soil water beneath the native vegetation is consistent with the theory that some relatively recent water (after 1960) has penetrated to depths of at least 12 m along channels occupied by living roots. Where the native vegetation has been cleared, no water which fell as rain since 1960 was found at depths greater than 2.5 m. Oxygen-18 and deuterium concentrations suggest that some water movement to the roots of the native vegetation is in the vapor phase. (Baker-IVI)
W84-05354

SCALED SPACE AND TIME VARIABLES IN SOIL-WATER AND GROUNDWATER FLUX-BOUNDARY PROBLEMS,
Rothamsted Experimental Station, Harpenden (England).Dept. of Physics.
E. G. Youngs.
Journal of Hydrology, Vol. 60, No. 1-4, p 303-309, January, 1983. 7 Ref.

Descriptors: *Soil water, *Diffusion coefficient, Diffusion, Absorption, Groundwater recharge, Wells, Groundwater.

Scaled space and time variables may be used in presenting in compact general form solutions of the diffusion equation with flux boundary conditions. Variables for use in soil-water and groundwater problems are given for flux-boundary conditions that are proportional to the time raised to some power, of which the constant flux-boundary condition is a particular case. In the general case of time-dependent surface fluxes, the scaling of variables is possible in certain circumstances. These scaled variables may be used in one-dimensional problems of soil-water absorption and of groundwater recharge, and also in radial problems, such as water movement to plant roots and of water abstraction by wells. (Baker-IVI)
W84-05363

OBJECTIVE ASSESSMENT OF SOIL-MOISTURE DEFICIT MODELS,
Institute of Hydrology, Wallingford (England).
I. R. Calder, R. J. Harding, and P. T. W. Rosier.
Journal of Hydrology, Vol. 60, No. 1-4, p 329-355, January, 1983. 6 Fig, 3 Tab, 18 Ref.

Descriptors: *Soil water, Model studies, Water stress, Grasslands, Mathematical equations, Evaporation, Rainfall, Spatial distribution, Transpiration.

The performance of different soil-moisture deficit models was assessed by comparing model predictions with over 3000 neutron-probe observations of soil moisture content at six grassland experimental sites. The models were formulated using combinations of different equations for estimating potential evaporation and different regulating functions relating actual to potential evaporation via the moisture status of the soil. The results indicate that more detailed potential evaporation equations do not necessarily result in improved soil moisture deficiency (SMD) predictions. Indeed the use of a simple climatological mean estimate of evaporation, which requires no measurement of the meteorological variables other than rainfall, when used in conjunction with a root constant regulating function produces marginally the best SMD predictions. The success of the climatological mean estimate at all sites and for all years clearly demonstrates the conservative nature of potential evaporation within the United Kingdom both spatially and temporally on an annual basis. However, a further mechanism is needed to contribute to this apparent conservatism by not allowing the grass transpiration to respond fully to variations in atmospheric demand. In addition to the SMD negative feedback mechanism which limits transpiration in times of high SMD, there is another, independent, negative feedback mechanism which limits transpiration in times of high atmospheric demand. Successive improvements to the soil aspects of the model by incorporating either a layer formulation or a root constant did result in significantly improved model fits. (Baker-IVI)
W84-05365

SOIL-WATER FLUX SENSOR AND ITS USE FOR FIELD STUDIES OF TRANSFER PROCESSES IN SURFACE SOIL,
Oita Univ. (Japan).
For primary bibliographic entry see Field 7B.
W84-05366

2H. Lakes

PROPORTION OF EMPNEUSTON AND TOTAL ATMOSPHERIC INPUTS OF CARBON, NITROGEN AND PHOSPHORUS IN THE NUTRIENT BUDGET OF A SMALL MESOTROPHIC LAKE (PIBURGER SEE, AUSTRIA),
Innsbruck Univ. (Austria). Inst. of Zoology.
R. Psenner.
Internationale Revue der Gesampten Hydrobioloie, Vol. 69, No. 1, p 23-39, 1984. 6 Fig, 6 Tab, 62 Ref.

Descriptors: *Empneuston, *Nitrogen, *Phosphorus, *Nutrient budget, *Mesotrophic lake, *Piburger, *Austria, Cycling nutrients, Nutrients, Organic carbon, Litter, Airborne detritus, Decomposition.

Litter and wet traps were employed to determine the inputs of coarse organic matter (empneuston), total organic carbon, total nitrogen and phosphorus through dry fallout and precipitation to a soft-water, mesotrophic lake. The dispersal of airborne material over the lake surface was investigated, and a method for the calculation of total input was developed. The component of the particulate matter larger than 1 mm contained the largest proportion of organic carbon, while the dissolved and the fine particle (smaller than 1 mm) fractions made greater contributions to the inputs of nitrogen and phosphorus compounds. The importance of the large particle fraction of the airborne organic matter in the lake's nutrient budget during the autumnal fall of litter was confirmed. The maximum total airborne input seems to occur during spring and summer. The input of phosphorus compounds through the atmosphere to small forest lakes is large compared to that from other sources. Airborne material accounts for 39% of the total phosphorus loading. (Murphy-IVI)
W84-04893

PRIMARY PRODUCTION CHARACTERISTICS OF A HIMALAYAN LAKE IN KASHMIR,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
A. Wanganeo.
Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 1, p 79-90, 1984. 4 Fig, 7 Tab, 23 Ref.

Descriptors: *Primary productivity, *Lake Manasbal, *Kashmir, Nannoplankton, Thermal stratification, Seasonal variation, Phytoplankton, Bicarbonates, Calcium, Nutrients.

Lake Manasbal is the only valley lake in the region studied with a true thermal stratification during the summer season. The lake is situated in the Kashmir Himalayan Region at about 1584 m.s.l. at 34 degrees 15 min N, 74 degrees 40 min E. The lake water is alkaline and well buffered. Calcium is the predominant cation, and bicarbonate is the predominant anion. The production was dependent on the quantity of nutrients supplied. The carbon fixation rate has increased during the years 1971 to 1979. The fixation recorded ranged from between 17.2 mgC/sq m/day and 1281.21 mg C/sq m/day. The overall production pattern was bimodal, with a minor peak in spring (719.3 mg C/sq m/day) and a major one in summer (1496.2 mg C/sq m/day. The nannoplankton was responsible for most of the carbon fixation (69%), and the lake was classified as low productive in comparison to other lakes in the region. (Baker-IVI)
W84-04895

ABUNDANCE AND COMMUNITY STRUCTURE OF LIMNETIC ZOOPLANKTERS IN KUMAUN LAKES, INDIA,
D.S.B. Constituent Coll., Naini Tal (India). Dept. of Zoology.
P. C. Sharma, and M. C. Pant.
Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 1, p 91-109, 1984. 12 Fig, 3 Tab, 72 Ref.

Descriptors: *Zooplankton, *Primary productivity, *Lake Nainital, *Lake Bhimtal, *India, Eutrophication, Seasonal variation, Thermal stratification.

The zooplankton compositions in the limnetic zones of two subtropical lakes, the Nainital and the Bhimtal, India, were more or less similar in terms of species composition. Numerically, zooplankters were abundant during the thermal stratification (summer-autumn) period and scarce during the over-turn (winter). The density of the zooplankton population reported from the eutrophic Lake Nainital was higher than in the aligotrophic Lake Bhimtal. A bimodal pattern in the zooplankton abundance was recorded for Lake Bhimtal, whereas a third peak was also observed along with two peaks in Lake Nainital. Among the three groups studied copepods dominated over cladocerans and rotifers in both the lakes. The low species diversity and the absence of Daphnia sp. (a dominant zooplankter in Lake Bhimtal) in Lake Nainital probably indicates the advanced stage of eutrophication in lake Bhimtal. The Shannon Weaver diversity was higher for Lake Bhimtal than for Lake Nainital. (Baker-IVI)
W84-04896

INFLUENCE OF NATURAL ORGANIC MATTER ON THE ADSORPTION PROPERTIES OF MINERAL PARTICLES IN LAKE WATER,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
P. Baccini, E. Grieder, R. Stierli, and S. Goldberg.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 1, p 99-116, 1982. 9 Fig, 11 Tab, 20 Ref.

Descriptors: *Lakes, *Minerals, *Adsorption, *Organic matter, *Lake Alpnach, *Switzerland, Copper, Zinc, Hydrogen phosphate, Lake sediments.

The absorption characteristics of a well defined mineral particle, gamma-aluminum oxide, and a natural particle, Bg, isolated from the sediment surface of Lake Alpnach, were studied under lake water conditions. A method was developed to measure adsorbed organic matter as organic carbon on mineral particles, which were suspended at low concentrations in filtered lake water or in an electroyte solution of .002 M NaHCO3. At pH 8, and particle concentrations between 2 and 16 mg/l, natural organic matter (NOM) in the system reduced significantly the adsorption of copper, zinc, and hydrogen phosphate ions. Model calculations support the hypothesis that NOM can saturate the binding sites of the mineral surface at low particle concentrations preventing other ions from being adsorbed. The observed differences between copper and zinc adsorption can be explained by the differences in speciation due to NOM. The results of the experiments can also explain the findings that in prealpine lakes allochthonous particles are not very efficient scavengers while passing through the lacustrine water column. (Baker-IVI)
W84-04904

ICE COVER AND HYPOLIMNETIC REOXYGENATION IN THE GREIFENSEE FROM 1950 TO 1980 (EISBEDECKUNG UND HYPOLIMNISCHE SAUERSTOFFANREICHERUNG IM GREIFENSEE VON 1950 BIS 1980),
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
E. A. Thomas, and C. G. Orn.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 1, p 117-148, 1982. 11 Fig, 4 Tab, 11 Ref.

Descriptors: *Ice cover, *Wind, *Switzerland, *Greifensee, *Oxygenation, Oxygen deficit, Hypolimnion, Dissolved oxygen, Lakes.

From 1949 to 1980 the Greifensee was completely ice-covered for an estimated duration of 481 days. The longest period of ice cover, 82 days, occurred in 1963. During all periods of ice cover a total wind distance travelled by winds greater than 10 km/hr of 12,702 km was recorded at the nearby meteorological station Zurich SMA. The strong empirical relationships found between wind and hypolimnetic oxygen content in years with and without ice cover are schematized. When ice cover strongly limits wind action on the lake surface, the absolute oxygen deficit at the end of the preceding summer stratification will only be partly compensated in the following cold half-year. In 2 of the 13 years with ice cover, autumnal cooling was normal, but as fast heating, coupled with poor wind action, prevented any net oxygen increase following the breakup of the coat of ice, the annual oxygen maximum was found abnormally early, in January, prior to the ice cover. Disastrous oxygen conditions result if unfavorable mixing during autumnal cooling is followed by an early ice cover of long duration, succeeded by rapid initial summer heat uptake. This was the case in the worst oxygen year, 1971, when the hypolimnetic oxygen content in April amounted to only 20% of the April content in the best oxygen year, 1950. It is estimated that the loss of anemogenic oxygen increase caused by ice in the 121 years with ice winds to be 986 t or less than 4% of the total oxygen increase in all 30 years investigated. However, more than half of this hypothetical loss resulted in two years only, 1963 and 1971, the effect in these two years being an abnormaly early depletion of hypolimnetic oxygen reserves. The study underlines the necessity of a consistent registration of time and duration of ice cover on lakes. (Baker-IVI)
W84-04905

BACTERIAL DECAY OF THE AUTUMNAL PHYTOPLANKTON IN LAKE CONSTANCE (BODENSEE),
Konstanz Univ. (Germany, F.R.). Limnological Inst.
M. Simon, and M. M. Tilzer.
Schweizerische Zeitschrift fur Hydrologie, Vol 44, No 2, p 263-275, 1982. 5 Fig, 35 Ref.

Descriptors: *Phytoplankton, *Lake Constance, Bacteria, Seston, Bacteria, Biomass, Chlorophyll, Pheopigments, Particulates, Organic carbon, Detritus, Decomposition.

The breakdown of autumnal phytoplankton was studied in Lake Constance by combining chemical seston analyses, bacterial counts and scanning electron microscopy. Phytoplankton biomass reached a maximum in October with euphotic chlorophyll a concentrations of 8 mg/cu m. During November, phytoplankton biomass decreased leading to chlorophyll a concentrations of below 2 mg/cubic m. When phytoplankton biomass was high pheopigments comprised about 40% of total pigment concentration within the euphotic zone. Below 20 m depth pheopigments were usually in excess of chlorophyll a. High phytoplankton biomass was associated with small numbers of bacteria. Total particulate organic carbon exceeded biomass carbon by a factor of 4-10. Detrital aggregates were colonized by bacteria to varying degrees. Small particles near the lake surface were colonized by small rods and cocci. The degradation of algal detritus occurs in two steps. First, easily degradable dissolved material is released by dying cells and serves as a substrate for free-living bacteria. In a second stage bacterial colonization and degradation of particulate organic material occurs. On a vertical scale the final stage of decay of detritus is characterized by minimal bacterial attachment. It is likely that the remains of detrital particles consist of highly refractory material that cannot be used by bacteria any further. Chemically inert particles show some bacterial attachment. During the vegetation period, particles serve both as nutrient source and attachment matrix. During winter, by contrast, inert particles dominate that merely serve as attachment sites with only negligible nutritive value. (Baker-IVI)
W84-04914

CLADOCERA REMAINS IN RECENT SEDIMENTS AS INDICES OF CULTURAL EUTROPHICATION OF LAKE COMO,
Milan Univ. (Italy). Lab. di Limnologia.
G. Parise, and A. Riva.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 277-287, 7 Fig, 1 Tab, 30 Ref.

Descriptors: *Eutrophication, *Lake Como, *Italy, *Cladocera, Organic matter, Nitrogen, Chlorophyll, Daphnia, Acroperus, Nutrients, Lake sediments, Urbanization, Agriculture, Industrial wastes, Environmental effects.

Cladocera remains, organic matter, nitrogen, chlorophyll derivatives have been examined in the sediments to follow the trophic evolution of Lake Como. Four sediment cores were taken from the deepest (410 m) Italian lake at four stations and analyzed. The aim was to follow the productivity increase of Lake Como induced by the agricultural, urban and industrial development in the drainage basin. The most abundant Cladocera found are Bosmina sp., Daphnia sp., Chydorus sphaericus, Sida crystallina, Acroperus harpae, Leptodaro kindtii, Alona affinis. The most superficial portions of sediment reflect the remarkable biological and chemical changes in the water body in the last years. In the southern basins the frequency of Bosmina remains registers a high increase while Daphnia and Chydorus decrease progressively. Sida and Acroperus seem to disappear from these basins in a period included between 1960 and 1970. In the northern basins the increase of Bosmina, Daphnia, Chydorus and Acroperus remains is observed, while Sida registers an increase at Spartivento and is absent at Oligiasaca. Organic matter, nitrogen, chlorophyll derivatives register in the four stations considerable increases more remarkable in the two southern basins. The general increase noted in trophic stage is more remarkable in the southern basins, heavily influenced by the activities of the towns of Como and Lecco, than in the less densely populated northern basins. (Baker-IVI)
W84-04915

ANALYSIS AND CHARACTERIZATION OF NATURAL ORGANIC MATTERS IN FRESHWATERS II. COMPARISON OF THE PROPERTIES OF WATERS OF VARIOUS ORIGINS AND THEIR ANNUAL TREND,
Geneva Univ. (Switzerland). Dept. of Inorganic, Analytical and Applied Chemistry.
J. Buffle, and P. Deladoey.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 363-391, 1982. 18 Fig, 6 Tab, 25 Ref.

Descriptors: *Organic matter, *Water properties, Physical properties, Hydrologic cycle, Flocculation, Ions, Inorganic compounds.

A comparison is done between the properties of organic matters of a series of natural waters, of water extracts of soils and of products of in vitro decomposition of leaves. The properties of 'soluble' (< 0.2 micro m) organic matters of freshwaters are compared on the basis of their spectrometric properties (fluorescence and UV absorption), their complexation capabilities for Cu(II), their adsorption ability on kaolinite and their size (ultrafiltration). These parameters were studied for a series of various waters and their annual trends were measured. Correlations between the parameters related to organic matters and the concentrations of inorganic ions (particularly Fe, Al, Si, Ca) or pH were also examined. The results indicate that spectrometric parameters are mainly a measure of fulvic compounds of the water masses, whose origin is mostly the leaching of the surrounding lands. These compounds may be separated from other types of organic matters, from Si(IV) and Ca(2+) and from a large portion of Fe by ultrafiltration fractionation. Elimination of fulvic compounds from water masses could occur by means of adsorption on solid silicate or CaCO3, but flocculation does not seem to play an important role. Their complexing ability is large. (Murphy-IVI)
W84-04917

EQUILIBRIUM APPROACHES TO NATURAL WATER SYSTEMS - PART 2; IN SITU DETERMINATION OF THE EQUILIBRIA H2CO3 EQUILIBRIUM HCO3(-) + H(+) IN THE TEMPERATURE RANGE 4-18 DEGREES C IN A LAKE WATER OF 1.6 MM IONIC STRENGTH,
Umea Univ. (Sweden). Dept. of Inorganic Chemistry.
J. Liden.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 393-404, 1982. 2 Fig, 1 Tab, 19 Ref.

Descriptors: *Lakes, *Chemical properties, *Equilibrium constant, *Carbonic acid, Bicarbonates, Acidity, Carbonic acid, Natural waters, Hydrogen ion concentration.

The apparent equilibrium constant for the first acidity constant of carbonic acid has been determined in a lake water of 1.6 mM ionic strength in the temperature interval 4-19 degrees C. The experimental method used comprises pH measurements in situ with a probe and an IR-method for the selective determination of bicarbonate and carbonate ions in water samples. Because the in situ determination of an equilibrium constant in a natural water is a new approach, the different experimental conditions must be carefully considered. The quantitative calculation based on in situ equilibrium parameters can be justified. It appears that the use of a pH scale based on concentrations would facilitate the use of equilibrium constants in natural waters. (Baker-IVI)
W84-04918

SURFACE SEICHES OF LAKE OF ZURICH,
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
K. Hutter, G. Raggi), C. Bucher, and G. Salvade.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 423-454, 1982. 16 Fig, 3 Tab, 42 Ref.

Descriptors: *Seiches, *Lake of Zurich, Surface water, Hydrologic models, Mathematical models, Physical properties, Switzerland.

A computational analysis of the periods and structure of surface seiches of Lake of Zurich and its experimental verification from three simultaneous water gauge recordings, mounted along the shores in Zurich, Pfaffikon and Rapperswil is given. After a brief historical account the governing equations and the procedure, how they were discretized by a finite element technique are introduced. Computational results concern seiche periods and seiche structure, in particular co-range and co-tidal lines for the first seven free oscillations which are discussed in detail. Experimental verification is from recordings taken during January 1982. Inspection by eye allows identification of the three lowest order seiche periods including the phase shift between the recordings of Zurich and Rapperswil. Higher order modes (up to order 19) are also detected by this method. Power spectral analysis including interstation phase shift and coherence allow identification of over fifteen seiche periods. Agreement between the theoretically predicted and experimentally determined periods is excellent for the first, second, third, fair for the fourth, fifth and sixth mode and good for the other higher modes, but statistical reliability is low for these. (Author's abstract)
W84-04920

SURFACE SEICHES OF LAKE OF LUGANO,
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
K. Hutter, G. Raggio, C. Bucher, G. Salvade, and F. Zamboni.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 455-484, 1982. 22 Fig, 6 Tab, 15 Ref.

Descriptors: *Seiches, *Lake of Lugano, Graphical analysis, Surface seiches, Spectral analysis, Lake morphometry, Hydrologic aspects, Hydrologic data, Hydrologic properties, Hydrologic maps.

A computational analysis of the periods and structure of surface seiches of the southern basin of Lake of Lugano and its experimental verification from three simultaneous water gauge recordings, mounted along the shores of Agno, Morcote and Riva S. Vitale, is given. The first five theoretical modes are calculated with a finite element code of the tidal equations; it yields the eigenperiods and co-range and co-tidal lines, which are graphically displayed and discussed in detail. Experimental verification is from recordings taken during February/March 1982. Inspection by eye allows identification of the five lowest order modes, partly interstation phase shift. Power spectral analysis of three-times series and interstation phase difference and coherence spectra allow identification of higher order modes, probably up to order 13. Agreement between the theoretically predicted and the experimentally determined periods is excellent for all calculated modes. Computational results for the four lowest modes and their structure of the northern basin of Lake of Lugano are also presented and experimentally verified with records taken from an event in August 1979. Agreement is again excellent. (Author's abstract)
W84-04921

PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERIZATION OF TWO NATURAL HABITATS OF TUBIFICIDAE: ENVIRONMENTAL ADAPTATIONS IN THE ENERGY METABOLISM OF THE WORMS (PHYSIKALISCHE, CHEMISCHE UND BIOLOGISCHE CHARAKTERISIERUNG ZWEIER TUBIFICIDEN-STANDORTE: ANPASSUNGEN IM ENERGIESTOFFWECHSEL DER WURMER AN DIE NATURLICHEN LEBENSBEDINGUNGEN),
Ulm Univ. (Germany, F.R.). Abt. Allgemeine Zoologie (Biologie II).
J. Seuss, E. Hipp, A. Hohenberger, and K. H. Hoffmann.
Archiv fur Hydrobiologie, Vol. 100, No. 1, p 45-59, April, 1984. 5 Fig, 2 Tab, 36 Ref.

Descriptors: *Tubificids, *Eutrophication, *Pond, *Brook, Dissolved oxygen, Oligochaetes, Seasonal variation, Tubifex, Phosphorus, Iron, Manganese, Ammonia, Sediments, Metabolism, Organic matter, Stratification.

Changes in physical and chemical composition during the course of a year were determined for surface and sediment water of an eutrophic pond and a brook in the area of Ulm/Donau (West Germany) for a characterization of two natural habitats of tubificids. The pond is characterized as highly eutrophic on the basis of its stratification for ammonia-N, phosphorus, iron, and manganese from the surface water to the sediment water. It exhibits a considerable oxygen deficiency twice a year. The brook also demonstrates eutrophication, but the dissolved oxygen content is not below 75% saturation. The low number of Tubifex tubifex and the additional reduction in total number of oligochaetes from autumn to spring are probably caused by the low tolerance of the worms to long-term anoxia under natural conditions. The energy metabolism of T. tubifex is optimally adapted to short-term fluctuations in oxygen content as well as to an enrichment of the sediment organic material (low molecular weight organic acids). (Moore-IVI)
W84-05003

SURVEY OF SODIUM AND CHLORIDE CONCENTRATIONS IN FLORIDA LAKES,
Florida Univ., Gainesville. Center for Aquatic Weeds.
D. E. Canfield, Jr.
Florida Scientist, Vol. 47, No. 1, p 44-45, Winter, 1984. 2 Fig, 1 Tab, 15 Ref.

Descriptors: *Lakes, *Sodium, *Chloride, *Florida, Chemical analysis, Minerals, Saline water intrusion, Coastal waters, Lagoons, Salt springs.

A survey of 165 lakes located in different geologic and physiographic regions was conducted to determine sodium and chloride concentrations. Sodium concentrations in the lakes ranged from 1.2 to 1200 mg/l and chloride concentrations ranged from 1.7 to 2300 mg/l. While there was considerable variabiliy in lake concentrations, analysis of the data indicates that there are distinct regional differences. A general increase in sodium and chloride concentrations occurs as one moves from northwest to southeast Florida. Lakes located on ridges such as the Mount Dora Ridge, the Deland Ridge, and the Lake Wales Ridge generally have lower concentrations than lakes located in the surrounding lowlands. Lakes of the middle and lower St. Johns River have high concentrations because of inputs of mineralized water derived from marine sediments and salt springs. Coastal lakes, especially coastal lagoon lakes like Western Lake have higher concentrations than inland lakes because of salt water intrusion. (Baker-IVI)
W84-05011

BAG EXPERIMENTS ON THE EFFECT OF PHOSPHORUS AND BASE ADDITIONS ON THE ALGAL BIOMASS AND SPECIES COMPOSITION OF AN ACID LAKE,
West Virginia Univ., Morgantown. Dept. of Biology.
For primary bibliographic entry see Field 5G.
W84-05013

PRODUCTION AND DISTRIBUTION OF THE MICROPHYTOBENTHOS IN THE SEDIMENT OF LAKE MIKOLAJSKIE,
Rostock Univ. (German, D.R.). Dept. of Biology.
N. Wasmund.
Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 2, p 215-229, 1984. 6 Fig, 5 Tab, 47 Ref.

Descriptors: *Algae, *Benthos, *Lake sediments, *Lake Mikolajskie, *Poland, Primary productivity, Distribution, Chlorophyll, Algal growth, Chlorophyll a, Littoral zone, Biomass.

Lake Mikolajskie is a eutrophic lake in the Mazurian lakes are of northeast Poland. Four stations in the shallow littoral zone of Lake Mikolajskie were investigated in regard to in situ primary production, pigment concentration and algal biomass in the sediment during the autumn of 1980. The sampling technique developed permitted the selection of different sediment strata and their transfer to the exposure vessels for production measurements. Gross production potential, chlorophyll a concentration and live algal biomass decreased with increasing sediment depth. The minima in chlorophyll a concentration and algal biomass often found at the sediment surface may be caused by removal of algae due to wave action or active diurnal migration of the algae. Only an intimation of a downward migration during the morning was noted, but the importance of wave action for the magnitude of the microalgal population is shown particularly clearly by comparison of the four stations, which differed substantially in their degrees of exposure. Phytoplankton primary production measurements performed at the same time showed that the microphytobenthos may be the most important producer in the shallow littoral zone. (Baker-IVI)
W84-05015

HOW CURRENTS ON DIFFERENT SIDES OF SUBSTRATES IN STREAMS AFFECT MECHANISMS OF BENTHIC ALGAL ACCUMULATION,
Michigan Univ., Ann Arbor. School of Natural Resources.
R. J. Stevenson.
Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 2, p 241-262, 1984. 11 Fig, 3 Tab, 53 Ref.

Descriptors: *Stream currents, *Diatoms, *Benthos, Eddies, Water currents, Species diversity, Reproduction, Colonization, Immigration, Aquatic habitats.

Benthic diatom accumulation rates and diversity were monitored for 32 days in five habitats where current conditions were different. After 32 days, diatom abundance in a sheltered habitat where eddies occurred over substrates was over eight times the abundance in a habitat that was exposed directly to the main flow of the stream (about 30 cm/sec). Diatom immigration rates and species richness of diatom taxocenes were negatively related to exposure; whereas, diatom reproduction rates, death rates and relative abundances of the eight dominant diatom species were not related to the small differences in current velocity that occurred. During the 32-day colonization period diatom immigration rates increased, species richness of diatom taxocenes increased and evenness of species abundances decreased. Species composition of diatom taxocenes shifted from a numerical dominance by fast immigrators to dominance by fast reproducers during the 32-day colonization. (Author's abstract)
W84-05016

EFFECTS OF CHRONIC TURBIDITY ON DENSITY AND GROWTH OF STEELHEADS AND COHO SALMON,
Idaho Cooperative Fishery Research Unit, Moscow.
J. W. Sigler, T. C. Bjornn, and F. H. Everest.
Transactions of the American Fisheries Society, Vol. 113, No. 2, p 142-150, March, 1984. 4 Fig, 4 Tab, 10 Ref.

Descriptors: *Fish behavior, *Turbidity, *Salmon, *Trout, Turbid water, Lakes, Rivers, Channels, Growth.

In general, more fish stayed in channels with clear water than with turbid water, and weight and length of both steelheads and coho salmon increased faster in clear water. In most tests there was a significant difference in growth rates between fish in clear versus turbid water. Fish reared in clear water were not always significantly larger than fish in turbid water, but were growing at faster rates. After longer periods of growth, greater divergence of weight and length between fish in clear versus turbid water presumably would have occurred. Densities of fish in the clear water channels, although not always statistically different, were consistently higher than those in the turbid water. Larger numbers of fish emigrated from the channel with turbid water than from the one with clear water during the first two diel cycles in each test, indicating the turbidity was stressful to the fish. Some fish that left the turbid water still had a portion of yolk sac left, indicating that inability to obtain sufficient food was not the principal reason for leaving. (Baker-IVI)
W84-05084

GROWTH CHARACTERISTICS OF AQUATIC MACROPHYTES CULTURED IN NUTRIENT-ENRICHED WATER: I. WATER HYACINTH, WATER LETTUCE, AND PENNYWORT,
Agricultural Research and Education Center, Sanford, FL.
K. R. Reddy, and W. F. DeBusk.
Economic Botany, Vol. 38, No. 2, p 229-239, April-June, 1984. 6 Fig, 4 Tab, 15 Ref.

Descriptors: *Aquatic plants, *Plant growth, *Macrophytes, *Florida, Biomass, Seasonal variation, Nutrients, Water hyacinth, Water lettuce, Pennywort.

Seasonal growth characteristics and biomass yield potential of 3 floating aquatic macrophytes cultured in nutrient nonlimiting conditions were evaluated in central Florida's climatic conditions. Growth cycle (growth curve) of the plants was found to be complete when maximum plant density was reached and no additional increase in growth was recorded. Biomass yield per unit area and time was found to be maximum in the linear phase of the growth curve; plant density in this phase was defined as 'operational plant density,' a density range in which a biomass production system is operated to obtain the highest possible yields. Biomass yields were found to be 106, 72, and 41 t (dry wt)/ha/yr, respectively, for water hyacinth (Eichhornia crassipes), water lettuce (Pistia stratiotes), and pennywort (Hydrocotyle umbellata). Operational plant density was found to be in the range of 500-2,000 g dry wt/sq m for water hyacinth,

200-700 g dry wt/sq m for water lettuce, and 250-650 g dry wt/sq m for pennywort. Seasonality was observed in growth rates but not in operational plant density. Specific growth rate (% increase per day) was found to maximum at low plant densities and decreased as the plant density increased. Results show that water hyacinth and water lettuce can be successfully grown for a period of about 10 mo, while pennywort, a cool season plant, can be integrated into water hyacinth/water lettuce biomass production system to obtain high yields in the winter. (Author's abstract)
W84-05096

APPLICATION OF A SIMPLE NUMERICAL WAVE PREDICTION MODEL TO LAKE ERIE,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
D. J. Schwab, J. R. Bennett, P. C. Lu, and M. A. Donelan.
Journal of Geophysical Research, Vol. 89, No. C3, p 3586-3592, May, 1984. 9 Fig, 2 Tab, 24 Ref.

Descriptors: *Lake Erie, *Waves, *Prediction, Mathematical models, Wave height, Wave period, Wave direction, Wind.

A parametric dynamical wave prediction model has been adapted and tested against semianalytic empirical results for steady conditions in a circular basin and extensive field measurements of wave height, period, and direction. The adapted numerical model accurately predicts the directional spreading of waves for uniform steady wind that Donelan (1980) had predicted analytically for fetch-limited waves. When the model was applied to the central basin of Lake Erie and the results compared to observations of wave height and period (at two points in the lake) and direction (at one point), results for wave height and direction estimates were excellent compared to measurements at a research tower off the southern shore, but computed wave heights were lower than observed at a weather buoy in the western part. The model somewhat underestimated wave periods at both places. Thus, with locally measured wind data as input, the model estimates wave height and direction well and wave period acceptably. (Author's abstract)
W84-05110

EFFECTS OF AERATION AND TEMPERATURE ON NUTRIENT REGENERATION FROM SELECTED AQUATIC MACROPHYTES,
Agricultural Research and Education Center, Sanford, FL.
R. A. Ogwada, K. R. Reddy, and D. A. Graetz.
Journal of Environmental Quality, Vol. 13, No. 2, p 239-243, April-June, 1984. 10 Fig, 1 Tab, 24 Ref.

Descriptors: *Aeration, *Temperature effects, *Nutrients, *Decomposition, Aquatic plants, Macrophytes, Nitrogen, Phosphorus, Eutrophic lakes, Waterhyacinth, Pennywort, Hydrilla, Cattails, Aerobic conditions, Anaerobic conditions.

In an aquatic system, macrophyte die-off may occur as a result of plant maturity, freeze damage, or herbicide damage. Batch incubation was used to investigate the effect of aeration and temperature on the N and P release by decomposing aquatic macrophytes in eutrophic lake water. Nutrient release by waterhyacinth (Eichhornia crassipes) pennywort (Hydrocotyle umbellata), hydrilla (Hydrilla verticillata), and cattails (Typha latifolia) was evaluated under aerobic conditions. Waterhyacinth plants tagged with N-15 were used to determine the N-15 release at varying temperature levels and under anaerobic (oxygen free) and low-dissolved O2 (open system where the only O2 source was diffusion through the overlying water) conditions. Nutrient release was found to be rapid initially due to solubilization, followed by slow nutrient release as a result of microbial decomposition. Under aerobic conditions, NO3(-) formation in the water was significantly related to C/N ratio of the plants. About 48 to 76% of the plant N and 67 to 90% of the plant P were released at the end of 105 d of aerobic decomposition. After 94 d, about 86 and 88% of N-15 was released from the plant tissue under anaerobic and low-dissolved O2 conditions, respectively. Nutrient release is dependent on the water temperature, indicating that N and P release from plant tissue will be slower in winter than in summer months. (Moore-IVI)
W84-05117

FUNCTIONAL PROPERTIES OF A MICROCOSM OF THE FRESHWATER BENTHIC ZONE AND THE EFFECTS OF 2,4-DICHLOROPHENOL,
Argonne National Lab., IL. Radiological and Environmental Research Div.
For primary bibliographic entry see Field 5C.
W84-05188

SPATIO-TEMPORAL VARIATION OF THE LITTORAL MACROBENTHIC COMMUNITY STRUCTURE IN A COLD CLIMATE (VARIATIONS SPATIALES ET SAISONNIERES DE LA STRUCTURE DE GROUPEMENTS MACROBENTHIQUES LITTORAUX EN CLIMAT FROID),
Quebec Univ., Trois-Rivieres. Groupe de Recherche sur les Ecosystemes Aquatiques.
B. Vincent.
Hydrobiologia, Vol. 102, No. 3, p 175-186, June, 1983. 6 Fig, 7 Tab, 35 Ref.

Descriptors: *Saint-Lawrence River, *Quebec, *Ecosystems, *Spatial variation, *Temporal variation, *Benthos, Seasonal variations, Icefoot, Ice cover, Species diversity, Benthic flora, Benthic fauna, Gastropods, Chironomids.

Spatio-temporal variations of macrobenthic community structure were studied in the littoral zone of the Saint-Lawrence River (Quebec). Its thermal regime is characterized by steep seasonal gradients from April to November and by a long ice-cover period with formation of an icefoot. Six sites were sampled each season for one year. Temporal variations are less important than spatial variations. They are mainly seasonal and depend on emergence and recruitment periods and on migrations but there are also long-term variations. An increase of the mean diversity index of sites corresponds to an increase of seasonal variations of community profile and to a decrease of seasonal variations of organism abundance; it is explained by a better exploitation of benthic resources rather than by environment stability. Spatial variations of community structure depend mainly on vegetation abundance. There is no faunal zonation corresponding to the icefoot action. In sites where Gastropods are abundant, icefoot does not change community profile but it explains diminutions of density and of species diversity. Chironomids are little affected by this phenomenon. (Author's abstract)
W84-05202

TWO DIFFERENT METHODS OF EVALUATING NUTRIENT LIMITATIONS OF PERIPHYTON BIOASSAYS, USING WATER FROM THE RIVER RHINE AND EIGHT OF ITS TRIBUTARIES,
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
F. Schanz, and H. Juon.
Hydrobiologia, Vol. 102, No. 3, p 187-195, June, 1983. 5 Fig, 5 Tab, 25 Ref. Swiss National Science Foundation grant 3.075.76.

Descriptors: *Limiting nutrients, *Periphyton, *Rhine River, Water quality, Nitrogen, Phosphorus, Algal growth potential, Bioassay, Nitrates, Nitrites, Ammonia, Phosphates.

A graphical method and a calculative method are tested for determining the limiting nutrients in bioassays using values of selected chemical properties and results of biotests carried out with microperiphyton (a mixture of several algal species, not axenic). The data used were obtained from the River Rhine (two stations) and eight of its tributaries in 1978 and 1979. Determinations of the following inorganic substances were made: PO4(3-)-P; NO3(-)-N; NO2(-)-N; NH4(+)-N and Cl(-). In addition, pH and carbonate alkalinity were measured. Bioassays to obtain the algal growth potential (AGP) were carried out using periphyton from the River Rhine. A linear relationship could be established between NO3(-)-N and the AGP, while the AGP, while the AGP showed a non-linear dependence on the PO4(3-)-P concentration. The critical N/P ratio for N or P limitation of the algal growth in bioassays was evaluated graphically and by calculation. The results of the two methods are in good agreement: N is the limiting factor at NO3(-)-N/PO4(3-)-P ratios less than 10, while P is limiting at ratios greater than 20. At values between 10 and 20 neither N nor P can be supposed with certainty to be limiting. Either of the two methods may be used to determine whether nitrogen or phosphorus is the probable factor limiting algal growth. An accurate determination of the limiting factor is only possible following experiments where the nutrients are added prior to the beginning of the test, a procedure which is not always practicable when analyzing water quality. (Moore-IVI)
W84-05203

EFFECTS OF ARTIFICIAL DESTRATIFICATION ON ZOOBENTHOS AND ON THE TROPHIC STATUS OF A POLISH RESERVOIR,
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
S. Wielgosz.
Hydrobiologia, Vol. 102, No. 3, p 197-23, June, 1983. 4 Tab, 28 Ref.

Descriptors: *Reservoirs, *Benthos, *Destratification, *Trophic status, *Poland, *Lake Mutek, Stratification, Eutrophication, Zoobenthos, Littoral zone, Fauna.

The macrobenthic fauna, especially the Chironomidae, and the sequence of faunal groups in a horizontal transect across Lake Mutek were studied before and after artificial destratification. Prior to destratification, Chironomidae dominated in the littoral, constituting 45.1% of numbers, and 54.5% of biomass, and ranking before Oligochaeta. The following frequency of chironomids was observed: Cladopelma viridula (8.03%), Polypedilum nubeculosum (7/.4%), and Chironomus plumosus (6.44%). During destratification in 1979, there was a 3-fold increase in zoobenthos abundance and a 1.5-fold increase in biomass. Changes took place in the dominance order of chironomid species. An increase in the abundance of the littoral zoocenosis was connected with increasing trophy in the zone. There was a 6-fold increase in the density of Oligochaeta, a 3-fold increase of Chironomidae and a 20-fold reduction in Chaoborus flavicans in the sublittoral. Chironomus plumosus and Tanypus kraatzi were dominant among the Chironomidae. The greatest changes were observed in the communities of the pelagial. In the 1977-1979 period, Lake Mutek belonged to the Chaoborus Lake type - that is it was polytrophic with restricted mixis. During re-aeration Lake Mutek changed into a eutrophic lake. (Baker-IVI)
W84-05204

SAYNAJALAMPI AND THE DIFFICULTIES INHERENT IN THE DATING OF SEDIMENTS IN A HARD-WATER LAKE,
Uppsala Univ. (Sweden). Fysiska Institutionen.
I. U. Olsson, F. El-Daoushy, and Y. Vasari.
Hydrobiologia, Vol. 103, p 5-14, July, 1983. 8 Fig, 1 Tab, 41 Ref.

Descriptors: *Paleolimnology, *Saynajalampi, *Finland, *Radioisotope dating, Limnology, Carbon radioisotopes, Polonium, Radium, Lead radioisotopes, Drainage effects, Hard water, Lake sediments, Submerged plants.

Saynajalampi is a small lake in the northern part of Kuusamo, Finland. The immediate vicinity of the lake comprises land which was previouly rich fen but has now been mostly cleared and reclaimed for agriculture. Previous measurements of the C-14 activity of lake sediments from Saynajalampi indicated a severe hard-water effect. Samples from cores, collected in 1977, were sliced into thin sec-

tions down to 18 cm. Light-colored layers, apparently due to catchment drainage, were used together with density diagrams to correlate the cores. The drainage history gives a time-scale showing that the lowest samples dated were just old enough to be pre-bomb sediments. Three samples of submerged plants were also examined, indicating some exchange with the air and an appreciable reservoir age. The activity of the plants was significantly lower in 1978 than in 1970. One sample, well below the lowest drainage stratum, indicates a reservoir age of ca. 1100 years. This sample yielded an apparent age of the insoluble (INS) fraction which was significantly different from that of the soluble (SOL) fraction. The SOL fraction appears younger than the INS fraction. The difference was determined to ca. 600 years. Total Pb-210 was determined via Po-210 using isotope dilution while Ra-226 was measured with the help of radon emanation. The Ra-226 was used to estimate the supported Pb-210. The unsupported Pb-210 showed a higher sediment accumulation rate for the top nine cm of one core (the length investigated was 16.5 cm). The varying accumulation rate was explained by human activities, as could be seen from the heterogenous sediment composition of the cores. Pollen analysis does not give any reliable indication of agriculture. The apparent C-14 age of the sediment is due partly to old bicarbonate and in situ contamination. When erosion occurs because of drainage old organic material is also introduced. (Moore-IVI)
W84-05205

USE OF FALLOUT 137CS AND 239,240PU FOR DATING OF LAKE SEDIMENTS,
Helsinki Univ. (Finland). Dept. of Radiochemistry.
T. Jaakkola, K. Tolonen, P. Huttunen, and S. Leskinen.
Hydrobiologia, Vol. 103, p 15-19, July, 1983. 5 Fig, 2 Tab, 11 Ref.

Descriptors: *Lake sediments, *Dating, *Cesium radioisotopes, *Plutonium radioisotopes, Finland, Laukunpampi, Lovojarvi, Paajarvi, Varves, Fallout.

The distribution of Cs-137 and Pu-239,240 in sediment core samples of the Finnish lakes Laukunlampi, Lovojarvi and Paajarvi were determined. The sediment samples were collected using dry ice and liquid nitrogen freezing methods. The sediments of these lakes are annually laminated. A clear maximum concentration of Cs-137 and Pu-239,240 was found in sediment layers formed during 1962-1964, the years of maximum fallout, and the middle of the 1950's can be estimated from the Cs-137 and Pu-239,240 profiles. The highest concentrations, 11,500 and 820 pCi/kg dry wt for Cs-137 and Pu-239,240, respectively, were found in the sediment of Laukunlampi. The vertical distribution was similar for Cs-137 and Pu-239,240 in the lakes investigated. A slight migration of Pu-239,240 and Cs-137 was found and the migration of Cs-137 seems to be higher than that of Pu-239,240. The advantages of Cs-137 dating method are rapidity and simplicity. Pu-239,240 is preferable when the sample size is small. The agreement found between Cs-137 and Pu-239,240 dates and the annual laminate show that these fallout radio isotopes can be used for dating sediments formed during the past 25 years. (Author's abstract)
W84-05206

CAESIUM-137 PROFILES IN THE SEDIMENTS OF A PARTIAL-MEROMICTIC LAKE ON GREAT SANDY ISLAND (FRASER ISLAND), QUEENSLAND, AUSTRALIA,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
M. E. Longmore, B. M. O'Leary, and C. W. Rose.
Hydrobiologia, Vol. 103, p 21-27, July, 1983. 4 Fig, 35 Ref.

Descriptors: *Cesium radioisotopes, *Lake sediments, *Hidden Lake, *Australia, Oligotrophic lakes, Fallout, Mixing, Diffusion, Bioaccumulation, Sediment recycling, Chemical stratification, Acidic water.

Hidden Lake is a perched, brown-water lake located in the center of Great Sandy Island (Fraser Is.), S.E. Queensland. It is highly acid (pH 4.0), oligotrophic and is thermally and chemically stratified for most of the year. The sediments revealed a Cs-137 profile which departed from the temporal pattern of Cs-137 fallout in Brisbane and was represented by an exponential increase of Cs-137 towards the surface sediments from ca. 32 cm depth. The possible causes of the divergent profile are discussed, including physical and biological mixing, lag in the transport of catchment material to the sedimentary basin, diffusion, recycling and biological concentration. It is hypothesized that a combination of the last four processes, with diffusion facilitated by the highly acid conditions, are the major causes of the observed Cs-137 profile. Possible recycling and bioconcentration of Cs-137 raises questions as to the validity of this method of dating in similar environmental conditions, and as to the interpretation of other paleochemical data. These hypotheses are to be tested against profiles obtained from C-14, Pb-210, Pu-239/240 analyses of the sediment, and the measurement of Cs-137 activity in the water and biota of the lake. (Author's abstract)
W84-05207

MINERAL MAGNETIC STUDIES OF LAKE SEDIMENTS,
Liverpool Univ. (England). Dept. of Geography.
F. Oldfield, C. Barnosky, E. B. Leopold, and J. P. Smith.
Hydrobiologia, Vol. 103, p 33-44, July, 1983. 5 Fig, 1 Tab, 23 Ref.

Descriptors: *Magnetic studies, *Minerals, *Lake sediments, Climates, Lake Washington, Erosion rates, Fire, Magnetic minerals, Sediment sources, Core logging.

This review outlines the origin and environmental significance of magnetic minerals in lake sediments. Attention is drawn to situations where the patterns of mineral magnetic variation is a reflection of processes other than changing erosion rates and fire incidence. In many cases simple variations in the concentration of primary magnetic minerals in allocthonous catchment-derived materials do not provide an adequate model of mineral magnetic variations in lake sediments. Depending on the environmental context, mineral magnetic variations can be used to aid the elucidation of a diversity of problems. The use of mineral magnetic techniques in sediment source tracing, paleoclimatic studies and the reconstruction of particulate pollution history is illustrated by means of case studies from Britain and North America. The value of magnetic susceptibility as an on-site core logging technique is shown by reference to data from Lake Washington. (Baker-IVI)
W84-05209

CHANGING PATTERNS OF SEDIMENT ACCUMULATION IN A SMALL LAKE IN SCANIA, SOUTHERN SWEDEN,
Coventry (Lanchester) Polytechnic (England). Dept. of Geography.
J. A. Dearing.
Hydrobiologia, Vol. 103, p 59-64, July, 1983. 3 Fig, 1 Tab, 18 Ref.

Descriptors: *Magnetic studies, *Lake sediments, *Scania, *Sweden, Magnetic minerals, Sedimentation, Cores, Climate, Deforrestation, Erosion, Infilling.

Magnetic susceptibility measurements have been used to correlate synchronous depths in cores of recent sediment taken from a small lake having an area of about 55 ha in Scania, southern Sweden. The three-dimensional picture of sediment accumulation which emerges provides a basis for studying sediment deposition patterns through time. Using a paleomagnetic chronology, the results indicate that the pattern and rate of accumulation have dramatically changed during the past 350 years. Semiquantitative studies of downcore sediment properties in a single core are thus difficult. The generally higher levels of accumulation rate in the later period could possibly reflect the low wet density values of the uppermost levels of sediment. Since different patterns of sediment accumulation are caused by changes to the internal dynamics of the limnic system, the observed patterns could be artefacts of complex slumping-redeposition cycles where different zones of the lake are periodically subject to gain or loss of sediment as thresholds for sediment slope stability are transgressed. On the basis of present evidence, sedimentation patterns may have altered in many small to medium sized lakes during the last few centuries as a result of deforestation, accelerated erosion and infilling, climatic change or water level lowering. (Baker-IVI)
W84-05210

TRACE ELEMENT ASSOCIATIONS AS INDICATORS OF SEDIMENT ACCUMULATION IN LAKES,
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
L. V. Sergeeva.
Hydrobiologia, Vol. 103, p 81-84, July, 1983. 1 Fig, 4 Ref.

Descriptors: *Trace elements, *Lake sediments, Geochemistry, Paleolimnology, Trophic level, Hydrological regime, Redox potential, Factor analysis.

A geochemical study of lacustrine sediments was undertaken as part of a major paleolimnological project concerned with the impact of man on lakes. Factor analysis was applied to the geochemical data obtained from a core from one lake. Three principal factors which explained most of the variance of the initial data were identified. Factor I is related to the organic:mineral component ratio of the sediment, and can be considered as an indirect index of change in lake trophic status through time. Factor II is related to the granulometric composition of the sediment and matches evidence for changes in the hydrological regime of the lake. Factor III reflects changes in redox potential and is more closely related to process occurring within the lake than other factors. Specific geochemical associations of elements are connected with each factor and are the factor indicators. The correlation of these associations are analyzed as geochemical indices of the variability of sediment accumulation conditions in time. (Author's abstract)
W84-05212

INTERPRETATION OF LAKE QUALITY FROM CONTEMPORARY DIATOM ASSEMBLAGES,
Joensuu Univ. (Finland).
P. Huttunen, and J. Merilainen.
Hydrobiologia, Vol. 103, p 91-97, July, 1983. 4 Fig, 1 Tab, 22 Ref.

Descriptors: *Water quality, *Diatoms, *Lake sediments, Lakes, Sediments, Detrended correspondence analysis, Correspondence analysis, Reciprocal averaging, Hydrogen ion concentration, Conductivity.

Diatom assemblages from the topmost sediment of 49 lakes were ordinated by means of a program for detrended correspondence analysis and reciprocal averaging (Decorana). The lakes were ordinated to at least five rather distinct groups. The characteristic taxa of each group are also presented. Those diatoms, such as Anomoeoneis serians, Cymbella hebridica, Eunotia faba, E. tenella, Frustulia rhomboides v. saxonica, Melosire lirata f. seriata, Navicula mediocris and N. subtilissima, that are usually found in most unproductive environments characterize one group. Species that in Finnish waters are often correlated with human impact, for instance Asterionella formosa, Cyclotella pseudostelligera and C. stelligera v. tenuis are found more or less frequently in another group. On the basis of the physico-chemical properties of both catchments and lake water the five groups are distinctly different. Many of the properties, such as conductivity, calcium content, field percentage and the pH of the water support the separation of the groups on algal criteria. Some of the relationships between the component score axes and water chemistry give useful information that can be applied to paleolimnological work. In general, one particular axis corresponds relatively well with the nutrient

status of the lake. There is also a good correlation between this axis and the pH of the water in autumn and this axis and conductivity. A second axis seems to reflect the depth of the productive water layer, measured by transparency and water color. Otherwise there is no clear dependence between the water parameters and higher axes. (Baker-IVI)
W84-05213

BACTERIAL DECOMPOSITION OF ORGANIC MATTER IN LACUSTRINE SEDIMENTS,
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
V. G. Drabkova.
Hydrobiologia, Vol. 103, p 99-102, July, 1983. 1 Tab, 8 Ref.

Descriptors: *Bacteria, *Decomposition, *Lake sediments, *Organic matter, *USSR, Oxygen consumption, Productivity, Redox potential, Aerobic decomposition, Oxygen demand.

Organic matter, redox potential, bacterial number, oxygen consumption by surface sediment and aquatic bacteria production were determined in lakes situated in the forest zone (Karelian Isthmus, Baltic zone, South Ural) and in the forest-steppe (South Ural) of the USSR. The lakes differ in bioproductivity and in the intensity of human influence. The amount of organic matter accumulating in the sediments is closely related to production and decomposition processes in the trophogenic layer. Processes of organic matter transformation were most active in the uppermost sediment. The quantity of bacteria shows no correlation with the organic matter content of the sediment. An increase in organic matter, up to 70-80% of dry weight, is often accompanied by a decrease in bottom bacteria. The intensity of aerobic decomposition of the labile organic matter can be judged from the oxygen demand of the sediments. It is important to differentiate between chemical and biological oxidation processes. The quantity of bottom bacteria correlates closely with the value of oxygen consumption only in cases of high sediment redox potentials. (Moore-IVI)
W84-05214

PALEOLIMNOLOGICAL RECONSTRUCTION OF THE EFFECTS OF ATMOSPHERIC DEPOSITION OF ACIDS AND HEAVY METALS ON THE CHEMISTRY AND BIOLOGY OF LAKES IN NEW ENGLAND AND NORWAY,
Maine Univ. at Orono. Dept. of Botany and Plant Pathology.
For primary bibliographic entry see Field 5C.
W84-05215

DIATOM AND CHRYSOPHYTE RELICT ASSEMBLAGES IN THE SEDIMENTS OF BLELHAM TARN IN THE ENGLISH LAKE DISTRICT,
Freshwater Biological Association, Ambleside (England).
E. Y. Haworth.
Hydrobiologia, Vol. 103, p. 131-134, July, 1983. 1 Fig, 6 Ref.

Descriptors: *Diatoms, *Lake sediments, *Blelham Tarn, *England, *Chrysophyta, Plankton, Algae, Environmental effects, Plowing, Drainage, Sedimentation, Eutrophication.

The diatom assemblage in the early nineteenth century was dominated by Cyclotella comensis Grun., C. praetermissa Lund, Achnanthes minutissima Kutz, and A. microcephala (Kutz) Grun. A series of changes in assemblages at horizons A-D has resulted in the present domination of Asterionella formosa Hassall and Melosira italica subsp. subarctica O. Muller, with other indicators of nutrient enrichment also present. Post-1947 sediments were identified by comparison with plankton records, and algal changes during that period indicate the environmental responses to changes in farming practice and domestic water supplies. It is evident from pollen and chemical data that man-induced changes in sediment deposition have occurred at various times during the last 5000 years. Correlation between minicores shows that the early ploughing, indicated by geochemistry caused little change in the diatom assemblage. Old maps show that land drainage took place between about 1830 and 1880 AD and included a slight lowering of the tarn water level. An increase in sediment accumulation rate at about 35-25 cm in core 74 AD coincides with the initial increase in Asterionella and the reappearance of Cyclotella pseudostelligera Hustedt/C. glomerata Bachman. (Baker-IVI)
W84-05217

CLADOCERAN REMAINS AS EVIDENCE OF CHANGE IN TROPHIC STATE IN THREE SWISS LAKES,
Indiana Univ. at Bloomington. Dept. of Biology.
M. M. Boucherle, and H. Zullig.
Hydrobiologia, Vol. 103, p 141-146, July, 1983. 3 Fig, 1 Tab, 17 Ref.

Descriptors: *Cladeceran, *Trophic level, *Lake Zurich, *Lake St. Moritz, *Lake Baldegg, *Switzerland, Paleolimnology, Sediments, Lake sediments, Ecological effects.

Historical information on trophic status provides useful data for management and restoration of lakes. Species composition and density of cladoceran populations changed in Lakes Zurich, St. Moritz and Baldegg as human populations increased in these watersheds. Lake Zurich sediments became annually laminated in the 1890's as a result of increased organic input as the size of the cities surrounding the lake grew. At the same time, the Bosmina species changed from a oligotrophic form (longispina) to a eutrophic form (longirostris). An increase in Daphnia spp. populations also occurred at this time in the lake's history. Bosmina longispina reappeared in the lake in 1965 as the lake's trophic status changed from eutrophic to mesotrophic due to effective sewage treatment facilities. Annual laminations appear in the Lake St. Moritz sediments about 1910. Shortly thereafter, a shift from B. longispina to B. longirostris occurred. This change in trophic status is associated with increased tourism in the area. Lake Baldegg sediments also show annual laminations beginning in 1885 and a similar shift in the Bosmina species. Other cladoceran remains were too scarce to be useful in interpreting the histories of these lakes. (Murphy-IVI)
W84-05219

EUTROPHICATION PROCESSES IN SPANISH RESERVOIRS AS REVEALED BY BIOLOGICAL RECORDS IN PROFUNDAL SEDIMENTS,
Barcelona Univ. (Spain). Facultat de Biologia.
N. Prat, and M. V. Daroca.
Hydrobiologia, Vol. 103, p 153-158, July, 1983. 5 Fig, 1 Tab, 17 Ref.

Descriptors: *Reservoirs, *Eutrophication, Trophic level, Fauna, Littoral zone, Nutrients, Oligotrophic lakes, Sediments, Insects, Crustaceans, Spain.

Eutrophication of reservoirs can be detected by changes in the abundance of insect and crustacean remains in the sediments. In recently built reservoirs, the time of impoundment can be determined through the presence of chironomid head capsules. The initial phase is characterized by highly enriched water as can be seen by the abundance of Bosmina remains. After this initial eutrophic phase, reservoirs become oligotrophic leaving few fossil remains in the sediments. But water level fluctuations are very important for the trophic status of reservoirs. A period of low water level may result in reservoir eutrophication and the development of a rich littoral fauna. (Baker-IVI)
W84-05221

SEASONAL EUTROPHICATION BY WILDFOWL IN BASINS ISOLATING FROM THE SEA; A WORKING HYPOTHESIS,
Naturhistoriska Riksmuseet, Stockholm (Sweden).
G. Linnman.
Hydrobiologia, Vol. 130, p. 159-163, July, 1983. 3 Fig, 12 Ref.

Descriptors: *Eutrophication, *Lakes, *Waterfowl, Birds, Basins, Scandinavia, Food chains, Seasonal variation, Paleolimnology.

A new and very special course of events starts in a freshwater basin just isolated from the sea. In Northwest Europe this is mainly caused by land uplift in Holocene times or by regression of the sea. Migrating birds, especially wildfowl, breeding, resting, and moulting in these often shallow, sheltered lakes along the Scandinavian coastlines might seasonally increase the alochthonous input of nutrients in the lake ecosystems and cause marked changes in biotic interactions. Wildfowl and other birds are seasonally important links in foodchains and affect the interplay of oganisms in lake basins, and even in an open bay or a fjord of restricted dimensions. They increase fertility by their droppings and by other organic matter, such as feathers and down, although they also take nutrients away from the water they visit. Birds such as swans and ducks also disturb the ordinary sedimentation of organic matter on the bottom by dipping and diving and by trampling in the littoral zone. A working hypothesis is suggested, that the wildfowl species in question were appreciably more numerous before the arrival of man. Consequently, their effect on seasonal eutrophication cannot be neglected in the paleolimnological context. (Baker-IVI)
W84-05222

EUTROPHICATION AND THE DISAPPEARANCE OF LAKES IN THE BRODNICA LAKE DISTRICT, NORTHERN POLAND AS A RESULT OF HUMAN INTERFERENCE,
Nicolas Copernicus Univ. of Torun (Poland). Inst of Geography.
Z. Churski.
Hydrobiologia, Vol. 103, p 165-168, July, 1983. 2 Fig, 4 Ref.

Descriptors: *Lakes, *Eutrophication, *Brodnica Lake District, *Poland, Drainage, Farming, Construction, Environmental effects, Water pollution effects.

A study area was selected located in an agricultural/forest region where human influence on lakes used to be minimal. The research area included about 100 lakes in Brodnica lake district in the Drweca river basin. Fifty of the lakes examined have an area less than 1 ha and a depth less than 5 m. The remaining 50 lakes have areas ranging from 1-300 ha and depths from 3-40 m. In the past 25 years a number of these lakes (29 of the 50 smaller ones) have completely disappeared and 21 others have become almost dry. Of the large lakes, 6 have disappeared and 3 are in an advanced stage of eutrophication and overgrowing. Human interference has included the pulling down of water mills (their function having been taken over by large state plants), drainage and river canalization, construction of holiday resorts without proper water purification systems, development of intensive farming with the accompanying use of mechanized farming practices, increased mineral fertilization, and the extension of roads and road traffic. (Baker-IVI)
W84-05223

RECENT GEOLOGIC DEVELOPMENT OF LAKE MICHIGAN (U.S.A.),
Illinois State Geological Survey Div., Champaign.
D. L. Gross, and R. A. Cahill.
Hydrobiologia, Vol. 103, p 193-198, July, 1983. 3 Fig, 1 Tab, 14 Ref.

Descriptors: *Lake sediments, *Lake Michigan, Great Lakes, Sediments, Sedimentation, Deglaciation, Sediment transport.

The stresses placed on Lake Michigan since the advent of industrialization require knowledge of the sedimentology of the whole lake in order to make informed decisions for environmental planning. Sediment accumulation rates are low. Areas of the lake receiving the most sediment average only 1 mm/a. Deep water basins average 0.1 to 0.5 mm/a. Large areas are not receiving any sediment.

Sediment was deposited rapidly, typically 5 mm/a, in the form of rock flour, during the deglaciation of both Lake Michigan and Lake Superior Basins. Then the rate of accumulation decreased by 80-90% and has remained relatively constant since final deglaciation. Sediment enters the lake from shoreline erosion, several small rivers, and by atmospheric transport. Except for the nearshore transport of sand by longshore drift, most of the sediment entering Lake Michigan is ultimately transported out to one of the depositional basins. Because active sedimentation occurs mostly in the deep water areas of the lake, the sediment remains undisturbed and contains a record of the chemical history of the lake. (Baker-IVI)
W84-05226

SEDIMENTARY CHEMISTRY OF A SMALL POLLUTED LAKE, GALLTRASK, S. FINLAND,
Helsinki Univ. (Finland). Dept. of Botany.
K. Tolonen, and J. Merilainen.
Hydrobiologia, Vol. 103, p 309-318, July, 1983. 5 Fig, 3 Tab, 24 Ref.

Descriptors: *Sedimentary chemistry, Water pollution effects, *Lake Galltrask, *Finland, Heavy metals, Accumulation, Chemical properties, Organic matter.

Lake Galltrask has been polluted by sewage discharge since the 1920s. At present the sediment-water contact experiences reducing conditions for long periods of the year. Macro nutrients N, P, K, Ca, Mg, Na and S as well as heavy metals Pb, Cu, Zn, Co, Cr, Ni, Fe and Mn were analyzed from a sediment core representing a 7000-year long history of a lake including the preceding brackish (Litorina Sea) and freshwater (Ancylus Lake) stages. Sediments were also analyzed for sedimentary pigments, algal growth potential (AGP) of the interstitial water, phosphorus fractions, pH, specific conductivity and redox potential. The annual accumulation values of several chemical elements were interpreted in light of other paleolimnological data from the same core. In the uppermost sediment stratum the influence of sewage pollution is clearly reflected by increases in total electrolyte content, pH, AGP and sedimentary pigments including myxoxanthophyll. Nickel, copper and manganese only slightly increase in the recent sediment, while other heavy metals (especially Cr and Zn) and sulfur, phosphorus, nitrogen and total organic matter are heavily concentrated in the polluted surface sediment. The interpretation of the chemostratigraphy of the lake accords with evidence of lake development based on biological analyses. (Murphy-IVI)
W84-05228

PRODUCTION OF PLANKTONIC ROTATORIA IN ORMAJARVI, AN EUTROPHICATED LAKE IN SOUTHERN FINLAND,
Helsinki Univ. (Finland). Dept. of Environmental Science.
For primary bibliographic entry see Field 5C.
W84-05231

ROTIFERS AS INDICATORS OF LAKE TYPES IN ESTONIA,
Akademiya Nauk Estonskoi SSR, Tartu. Inst. Zoologii i Botaniki.
A. Maemets.
Hydrobiologia, Vol. 104, p 357-361, August, 1983. 3 Fig, 5 Ref.

Descriptors: *Eutrophication, *Lakes, *Rotifers, *Estonia, Oligotrophic lakes, Mesotrophic lakes, Eutrophic lakes, Trophic levels.

Data on the pelagic rotifer fauna in 10 Estonian lakes accumulated over 20 years, as well as published data are analyzed. It appears possible to distinguish between three main indicator groups: oligotrophic and mesotrophic lake species; mesotrophic and eutrophic lake species; and eutrophic lake species. The first group includes Ploesoma hudsoni, Keratella serrulata, Synchaeta grandis, Asplanchna herricki, Ascomorpha ovalis, Gastropus stylifer, Conochilus hippocrepis, partially Conochilus unicornis and Kellicottia longispina, possibly also Ascomorpha testudo, and Gastropus minor. The second species grouping includes Trichocerca capucina, Filinia longiseta, F. limnetica, Keratella quadrata, K. cochlearis tecta, K. c. hispida, Polyarthra euryptera, Keratella hiemalis, Trichocerca porcellus, and T. pusilla. The third grouping includes Brachionus spp., Anuraeopsis fissa, Pompholyx sulcata, P. complanata, Trichocerca cylindrica, and Hexarthra mira. (Baker-IVI)
W84-05232

BIOLOGICAL REACTIONS IN WATERS (BIOLOGISCHE REAKTIONEN IN GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Ingenieurbiologie.
L. Hartmann.
Wasserwirtschaft, Vol. 73, No. 11, p 442-446, November, 1983. 5 Fig, 1 Tab, 10 Ref.

Descriptors: *Organic compounds, *Decomposition, *Productivity, Phototrophs, Chemoorganotrophs, Food chain, Metabolism, Microorganisms, Enzyme reactions.

Biological reactions in waters can be summarized as 'production' and 'degradation' of organics, with an equilibrium between phototrophic and chemoorganotrophic organisms. Such equilibria do exist only under a long term observation or in large systems. But in most biotopes, due to the influence of physical parameters, a difference exists over time or space between production and degradation. This is the more the case, if food chains with bigger chemoorganotrophs are established and distributed on a large area. The dominant parameters for the velocity of food uptake and metabolism are different between different systematic groups and also depends on the diversity of the biocommunity. For biocommunities with a high diversity therefore only a summarizing observation and description of systems is possible; but for isolated systems, consisting mainly of microorganisms, the mathematics of enzyme reaction can be applied. (Author's abstract)
W84-05261

RESPONSE OF AN ANTARCTIC LAKE HETEROTROPHIC COMMUNITY TO HIGH DISSOLVED OXYGEN,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. T. Mikell, Jr., B. C. Parker, and G. M. Simmons, Jr.
Applied and Environmental Microbiology, Vol. 47, No. 5, p 1062-1066, May, 1984. 4 Fig, 3 Tab, 30 Ref. NSF DPP-80-12988.

Descriptors: *Lake Hoare, *Antarctica, *Dissolved oxygen, *Ecological effects, Plankton, Heterotrophic bacteria, Population exposure, Chemical properties.

The upper waters of Lake Hoare, Antarctica, contain dissolved oxygen at about three times the normal saturation (> or = 42 mg/liter). The response of the heterotrophic plankton community to this high dissolved oxygen was evaluated by the criteria of CFU and D-(U-C-14) glucose assimilated-respired. High dissolved oxygen was not inhibitory to D-(U-C-14) glucose assimilation-respiration compared with normal atmospheric dissolved oxygen in Lake Hoare water. The D-(U-C-14) glucose assimilated-respired in the upper saturated atmospheric dissolved oxygen waters of Mountain Lake, Va., was inhibited in contrast to Lake Hoare ($P < 0.05$). CFU formation was inhibited in both lakes. CFU represent < 1% of the fluorochrome-stained direct counts in Lake Hoare. Lake Hoare planktobacteria are smaller than the planktobacteria in Mountain Lake. ATP size fractionation revealed that 39% of the ATP biomass was < 0.5 micro m in Lake Hoare. (Author's abstract)
W84-05279

GALLIONELLA FERRUGINEA AS DENITRIFICATION FACTOR IN WATER POOR IN ORGANIC MATTER (GALLIONELLA FERRUGINEA, FACTEUR DE DENITRIFICATION DANS LES EAUX PAUVRES EN MATIERE ORGANIQUE),
J.-L. Gouy, P. Berge, and L. Labroue.
Comptes Rendus Hebdomadaires, Seances Academie/Sciences Serie III, Vol. 298, No. 6, p 153-156, 1984. 1 Fig, 1 Tab, 9 Ref.

Descriptors: *Gallionella, *Denitrification, *Organic matter, Nitrogen removal, Nitrates, Iron, Self-purification, Ions.

Respiratory use of nitrates by heterotrophic bacteria is a well-known phenomenon, commonly seen in soil and in water in an atmosphere poor in oxygen (EL < 340 mv). Among the accountable strains isolated from the soil, 40-65% are capable of carrying out the first step, that is to say the reduction of nitrate to nitrites, but a great number more continue until obtaining gaseous products (NO, N2O, N2). Under anaerobic conditions, Gallionella ferruginea, a chemo-lithotroph iron bacteria, reduces nitrates to nitrites which, in turn, are reduced to gaseous nitrogen compounds by the ferrous ions present in the medium. This autotrophic denitrification could explain the nitrogenous purification of fresh waters, poor in organic matter. (Murphy-IVI)
W84-05286

PERIPHYTIC COMMUNITY ANALYSIS IN A SMALL OLIGOTROPIC LAKE,
Wilkes Coll., Wilkes-Barre, PA.
A. Nerozzi, and P. Siver.
Proceedings of the Pennsylvania Academy of Science, Vol. 57, No. 2, p 138-142, 1983. 7 Fig, 3 Tab, 21 Ref.

Descriptors: *Aquatic macrophytes, *Diatoms, *Lakes, Lake Lacawac, Lake Ariel, Pennsylvania, Oligotrophic lakes.

Periphytic diatom communities on four aquatic macrophytes (Brasenia schreberi, Orontium aquaticum, Sagittaria latifolia, and Pontedaria cordata) were studied in Lake Lacawac (Lake Ariel, PA), during the 1981 and 1982 growing seasons. Four sites were chosen to represent sand, mud, and bog habitats. The epiphytic diatom communities were very extensive in Lake Lacawac, and were very similar between macrophytes and habitat types, using the SIMI similarity index. In addition, communities were very stable over the two year period. Throughout the study the most dominant taxon was Tabellaria fenestrata. Achnanthes linearis, Gomphonema gracilis, and Fragilaria construens were of secondary importance. Attached diatom concentrations increased with progression of the growing season and were greatest at 15 to 45 cm from the surface. (Baker-IVI)
W84-05312

SPHAGNUM SPECIES COMPOSITION AND DISTRIBUTION IN THE BOGS OF NUANGOLA LAKE, LUZERNE COUNTY, PENNSYLVANIA,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Biological Sciences.
R. S. Wallace, and C. B. Reif.
Proceedings of the Pennsylvania Academy of Science, Vol. 57, No. 2, p 143-146, 1983. 2 Fig, 1 Tab, 17 Ref.

Descriptors: *Lakes, *Mosses, Sphagnum species, Nuangola Lake, Luzerne County, Pennsylvania, Bogs, Glacial lakes.

Thirteen species of Sphagnum moss were found in the four bog areas of Nuangola Lake, a glacially gorged basin at 335 m elevation. The areas were sampled by the transect-plot method and compared on the basis of their vascular plant cover and Sphagnum species distribution along the vegetational gradient. The Sphagnum species distribution followed the gradient of vascular vegetation when sampled using a transect-plot method, extending from the bog edge to the original lake shore. Five habitat zones were found, and Sphagnum species were distributed according to their trophic, light, and water requirements. Sphagnum fuscum, S. centrale, and S. recurvum were the dominant mosses, the first contributing more to peat formation at present. Besides the well known properties of Sphagnum in creating habitats for peat loving flora

and fauna, chemical effects of cation exchange and pH maintainance, the accumulation of Sphagnum peat to depths of several meters in Nuangola Lake bogs is an important factor effecting the limnology and succession of the lake. (Baker-IVI)
W84-05313

STUDY OF THE CYCLING OF MANGANESE AND OTHER ELEMENTS IN A SEASONALLY ANOXIC LAKE, ROSTHERNE MERE, U.K.,
Freshwater Biological Association, Ambleside (England).
W. Davison, and C. Woof.
Water Research, Vol. 18, No. 6, p 727-734, 1984. 6 Fig, 3 Tab, 40 Ref.

Descriptors: *Vertical distribution, *Lakes, *Manganese, Iron, Seasonal variation, Sediments, Lake sediments, Distribution, Sulfides, Hypolimnion, Thermal stratification, Stratification.

The vertical distribution of sulfate, dissolved sulfide, alkalinity, pH, total iron and manganese and humic substances was monitored for a year in Lake Rostherne Mere. During summer stratification Mn(II), probably of sediment origin, accumulated in the hypolimnetic bottom waters to a concentration of 50 microm. Release occurred in two stages and appeared to be related to the supply of organic material to the sediment. No ferrous iron or dissolved sulfide were detected in the water column, athough they were measured in the interstitial waters of the sediment. Ferrous sediment formation in the sediment controls the iron (II) and dissolved sulfide concentrations and so minimized the concentration gradients at the sediment-water interface. Electron acceptors other than oxygen are capable of oxidizing ferrous and sulfide ions in the water column, pH and alkalinity were the only other chemical components to show appreciable variations with depth, reflecting the biological processes of photosynthesis, respiration and decomposition. Deoxygenation of water above an active reducing sediment can be insufficient to ensure release of iron or sulfide from the sediment. The column of water must have sufficient reducing intensity, expressed in either a chemical or microbiological sense, to maintain these rapidly oxidized forms. Rostherne Mere is a finely poised system which shows manganese reduction and the initial stages of denitrification. Neither ferrous iron nor dissolved sulfide completely dominates the interstitial water and so both are maintained at low concentrations which restricts their transport to the overlying water. Any ferrous iron or sulfide which does transfer across the sediment-water interface must be oxidized by electron acceptors other than oxygen, such as nitrate and manganic ions. The lake therefore only reaches the first stage of the redox sequence observed in other systems, perhaps due to it being relatively deep with a commensurate large hypolimnetic volume which provides a substantial reservoir of substances able to consume electrons at each stage of the progression along the series of redox processes. Iron and humic substances simultaneously increased in the surface waters after a major flood indicating that they are both present in the solution in contact with the soils of the catchment. (Baker-IVI)
W84-05319

STUDY OF PHOSPHORUS PARTITIONING AND EXCHANGE IN A SOUTH AFRICAN IMPOUNDMENT,
National Inst. for Water Research, Pretoria (South Africa).
A. J. Twinch, and C. M. Breen.
Water Research, Vol. 18, No. 6, p 775-782, 1984. 4 Fig, 3 Tab, 30 Ref.

Descriptors: *Impoundments, *Phosphorus, South Africa, Radiochemical analysis, Kinetics, Enrichment, Nitrogen, Monitoring, Phytoplankton.

Radiochemical techniques were used to monitor the short-term exchange of phosphorus between soluble and particulate fractions in the water during enrichment experiments in a South African impoundment. Tracer uptake kinetics were examined under a range of conditions in the water, created by the use of a series of isolation columns. Labeled soluble fractions were separated by gel filtration and their exchange with the particulate fraction and with intact sediment cores were examined independently. Only two distinct soluble fractions were evident using the radiotracer method and their exchange characteristics with suspended particulate material and intact sediment cores differed markedly. Radiotracer partitioning contrasted with the phosphorus partitioning measured with standard chemical methods. From the data of this study the influence of nitrogen enrichment in sediment phosphate movement into the water is difficult to assess. From the similarities in response between the unenriched column and three of the four enriched columns it must be concluded that there is no evidence of a significant P flux into the phytoplankton in response to nitrogen enrichment. (Baker-IVI)
W84-05323

TEMPERATURE AND ENERGY BALANCE OF A WATER RESERVOIR DETERMINED FROM STANDARD WEATHER DATA OF A LAND STATION,
Royal Netherlands Meteorological Inst., De Bilt.
H. A. R. de Bruin.
Journal of Hydrology, Vol. 59, No. 3-4, p 261-274, November, 1982. 4 Fig, 8 Tab.

Descriptors: *Reservoirs, *Temperature, *Energy, Weather patterns, Model studies.

A model for the determination of the temperature and energy budget of a well-mixed water reservoir from standard meteorological data observed at a nearby land station is investigated. The main features are discussed. A verification of the model is given, consisting of a comparison over several years between the measured and calculated temperature of two adjacent water reservoirs. Simple modeling satisfactorily described the annual variation of temperature of this well-mixed reservoir under certain conditions. The attractiveness of the model is that it has a clear physical basis and it uses only standard meteorological observations. Moreover, because bodies of water with a depth of 10 m very often are mixed naturally by wind the model is of great practical importance. Applications of the model lie in the field of thermal pollution problems (determination of natural water temperatures, trend studies using time series of the natural water temperature computed from climatological data, and evaluation of frequency distributions of natural water temperatures), water budget studies (determination of evaporation), and planning purposes such as the estimation of the temperature of cooling ponds to be planned. (Baker-IVI)
W84-05341

2I. Water In Plants

ROOT WATER UPTAKE AND SOIL WATER DISTRIBUTION: TEST OF AN AVAILABILITY CONCEPT,
Texas A and M Univ., College Station.
R. J. Lascano, and C. H. M. van Bavel.
Soil Science Society of America Journal, Vol. 48, No. 2, p 233-237, March-April, 1984. 1 Fig, 4 Tab, 35 Ref.

Descriptors: *Root water uptake, *Soil water, *Availability concept, *Available water, Water distribution, Plant water potential, Soil water potential, Cotton, Leaf water potential, Roots, Hydraulic resistance, Transpiration, Soil-water-plant relationships.

Progressive decline of soil water supplies in the root zone causes a corresponding lowering of the water potential in the plant and symptoms collectively described as drought stress. It is currently believed that soil water availability is closely related to plant water potential. An experimental test was made of the hypothesis that the fractional water uptake by the root system from a soil layer is proportional to the root density and to the difference between the water potential in that layer and the mean leaf water potential. This theory adequately explained the water uptake by a cotton root system that was divided over a wet and dry soil compartment. It was also established that the absolute rate of water uptake from each compartment could be accurately calculated from the measured potential difference between soil and plant leaf, and from a separately measured plant hydraulic resistance, which was shown to have a value of 0.67 x 10 to the 9th power s, independent of transpiration rate. (Murphy-IVI)
W84-04870

EFFECTS OF TEXTURE ON THE RESISTANCE TO WATER MOVEMENT WITHIN THE RHIZOSPHERE,
Washington State Univ., Pullman.
K. L. Bristow, G. S. Campbell, and C. Calissendorff.
Soil Science Society of America Journal, Vol. 48, No. 2, p 266-270, March-April, 1984. 4 Fig, 1 Tab, 29 Ref.

Descriptors: *Water movement, *Soil texture, *Rhizosphere, Soil water, Soil-water-plant relationships, Irrigation scheduling, Root resistance, Transpiration, Plant water potential, Helianthus.

A growth chamber study was designed to investigate the relative importance of the resistance involved in water movement within the rhizosphere. The components considered are the soil, the soil-root interface, and the root itself. The plant species used was sunflower (Helianthus annus L.), grown in three soils of different textures. After several weeks of growth all water application was stopped and the soil allowed to dry by transpiration alone. Relevant destructive measurements were carried out during the course of the drying period, one pot being sacrificed for each set. Measurements included transpiration rate, soil and xylem water potential, rooting density, and hydraulic properties of the soils. As the soil dried, total resistance to water movement was found to increase most rapidly in the coarsest textured soil and least rapidly in the finest textured soil. A steady state model was used to partition the total resistance between the various resistive components. This enabled the root plus interfacial resistance to be quantified in terms of soil texture and water content. (Author's abstract)
W84-04875

SUBTROPICAL GRASS SPECIES RESPONSE TO DIFFERENT IRRIGATION AND HARVEST REGIMES,
Florida Univ. Agricultural Research Center, Ona.
P. Mislevy, and P. H. Everett.
Agronomy Journal, Vol. 73, No. 4, p 601-604, July-August, 1981. 5 Tab, 8 Ref.

Descriptors: *Grasses, *Crop yield, *Irrigation patterns, Clipping, Seasonal variation, Subtropic zone, Forage.

The effects of clipping height and irrigation were determined on seasonal distribution of forage yield and quality of 16 perennial grasses grown in a subtropical environment. Sixteen grasses (4 Cynodons, 3 Paspalums, 8 Digitarias, and 1 Brachiaria) were grown with or without irrigation and harvested at two stubble heights (5 and 10 cm) at 30 day intervals for 30 consecutive months. Winter forage production was highest for Cynodon spp. (27% of total annual yield) and lowest for Paspalum spp. (14% of total annual yield). Plants cut at a 5 cm stubble initially outyielded plants harvested at 10 cm. However, after 2.5 years little difference was noted except for the Paspalum spp. and Brachiaria sp. which continued to produce more forage at shorter heights. Higher in vitro organic matter digestion (IVOMD) percentages were obtained from plants cut short with no irrigation. Cynodons harvested at a 5 cm height produced highest dry matter production during the cool winter season, containing high crude protein and IVOMD levels. Dry matter yields in summer were 100 to 300% higher than in winter, however, forage quality was much lower during the summer. (Baker-IVI)
W84-04964

CANOPY TEMPERATURES, WATER USE, AND WATER USE EFFICIENCY OF CORN GENOTYPES,

Kansas Agricultural Experiment Station, Manhattan. Evapotranspiration Lab.
T. A. Mtui, E. T. Kanemasu, and C. Wassom.

Agronomy Journal, Vol. 73, No. 4, p 639-643, July-August, 1981. 6 Fig, 6 Tab, 8 Ref.

Descriptors: *Canopy temperature, *Water use, *Corn, Drought, Heat stress, Hybrids, Irrigation effects, Crop yield, Xylem water potential, Stomatal diffusive resistance.

Because the response of plants to drought and temperature stress involves genotype-environment interactions, one needs to obtain, identify, and measure the differential response displayed by the plant genotypes so as to be able to distinguish genotypes that respond well under favorable and unfavorable environments. A field study was conducted to compare two corn hybrids (Mo17 X B73, A619 X A632) and their respective inbred parents under irrigated and nonirrigated conditions. Canopy temperature, stomatal diffusive resistance, xylem water potential, leaf area index, ear dry weight, and grain yield were determined. Water use was determined from neutron moderation measurements of the soil-water profile. The soil was a fine silty, mixed mesic, Pachic Haplustoll that holds approximately 250 mm of plant available water. Hybrids had higher grain yield, water use, and water use efficiency than the inbred parents under both irrigated and nonirrigated conditions. Water use estimates for both hybrids and inbreds were greater for irrigated than for nonirrigated treatments. Early dry weight taken as early as one week after silking was a good indicator of final ear weight, and in this particular study, was an indicator of final grain weight. Canopy temperatures were cooler for hybrids than for the inbreds which is consistent with greater water use by the hybrids. (Moore-IVI)
W84-04966

RELATIONSHIP BETWEEN CROP TEMPERATURE AND THE PHYSIOLOGICAL AND PHENOLOGICAL DEVELOPMENT OF DIFFERENTIALLY IRRIGATED CORN,

Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
B. R. Gardner, B. L. Blad, R. E. Maurer, and D. G. Watts.

Agronomy Journal, Vol. 73, No. 4, p 743-747, July-August, 1981. 3 Fig, 2 Tab, 17 Ref.

Descriptors: *Temperature, *Water stress, *Corn, *Irrigation effects, Crop yield, Drought, Plant growth, Canopy temperature.

Quantitative data relating crop temperature under different water stress conditions to the phenological and physiological development of corn (Zea mays L.) over a growing season are lacking. This study was motivated by the need to obtain quantitative information which can be beneficially utilized by those involved in predicting crop yields and to assist those who assess the economic impact of drought on crop production. Infrared canopy temperatures and physiological and phenological measurements were made on differentially irrigated corn throughout the 1978 growing season. Irrigation treatments were designed to evaluate the effects of moisture stress on these measurements. The soil type in the experiment area is Valentine fine sand (Typic Ustipsamment). The effect of moisture stress on vegetative growth was demonstrated by an average height difference of 50 cm between fully irrigated and nonirrigated plants. There was a tendency for plants which had been subjected to moisture stress during the grain filling stage to mature faster than plants fully irrigated during that period. Yield reductions were greatest when stress occurred during the pollination or grain filling periods. Canopy temperature increases between the onset of tasseling and the end of grain fill were related to reduced yields. Five crop temperature indices were tested for their relationship to phenological stage of growth. Three were highly correlated, one had a low correlation, and one was not correlated with phenological development. (Author's abstract)
W84-04968

EFFECTS OF SEEDING DATE AND POPULATION ON WATER-USE EFFICIENCY AND SAFFLOWER YIELD,

Science and Education Administration, Mandan, ND. Northern Great Plains Research Center.
J. Alessi, J. F. Power, and D. C. Zimmerman.

Agronomy Journal, Vol. 73, No. 5, p 783-787, September-October, 1981. 4 Fig, 2 Tab, 14 Ref.

Descriptors: *Safflower, *Water use efficiency, *Crop yield, Soil water, Cultural practices, Seeding date, Plant population.

Oilseed crop production has increased greatly in the Northern Plains in recent years. Cultural practices to optimize oilseed production were studied for 4 years (1974-1977) to obtain information on safflower (Carthamus tinctoris L.) seed yield, oil concentration, and water-use efficiency as affected by seeding date and plant population. Safflower was seeded on previously cropped or fallow land on three dates: early (16 May), midseason (6 June), or late (25 June) on Temvik silt loam (Typic Haploborolls). Soil water depletion by safflower was generally confined to the upper 150-cm soil depth. Average water use by safflower seeded in mid-May was greater by 4 and 8 cm than that used by the midseason and late seeding, respectively, and was unaffected by population. Significant positive correlations ($r = 0.78$) were obtained between oil concentration and degree days for the period after flowering. Correlation coefficients showed that 79% of the total variation in oil concentration was accounted for by variation in water use and temperature. Average water-use efficiency for mid-May, early June, and late June seedings was 34, 33, and 15 kg seed/cm water used, respectively. Seed and oil yields were highest for early and lowest for late seeding. In all years, seeding date affected seed yield and oil concentration. Population affected seed and oil yield in 1976. The results showed that safflower grown under dryland conditions in the Northern Plains should be seeded not later than mid-May. Previous research in North Dakota showed that for best results safflower should be planted between 20 April and 10 May. (Author's abstract)
W84-04969

DETERMINING SOIL-INDUCED PLANT WATER POTENTIAL DEPRESSIONS IN ALFALFA BY MEANS OF INFRARED THERMOMETRY,

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
S. B. Idso, R. J. Reginato, D. C. Reicosky, and J. L. Hatfield.

Agronomy Journal, Vol. 73, No. 5, p 826-830, September-October, 1981. 6 Fig, 15 Ref.

Descriptors: *Alfalfa, *Soil-water-plant relationships, *Infrared thermometry, Remote sensing, Plant water potential, Forages, Water stress, Air temperature, Foliage temperature.

To ascertain the ability of a remote sensing technique to evaluate the soil-induced component of plant water potential depressions in forage crops, field experiments were conducted to measure the air vapor pressure deficit and foliage-air temperature differentials of well-watered alfalfa (Medicago sativa L.) at five different sites throughout the United States. At two of these sites, data were also acquired for various degrees of stressed alfalfa along with concurrent measurements of total plant water potential. The temperature and vapor pressure data were used to construct a plant water stress index which was related to the plant water potential. Different results were obtained for the two sites studied; but after a procedure was developed to remove variable atmospheric effects, the remaining soil-induced plant water potential depressions were found to be well described by a single function dependent upon the plant water stress index. These results demonstrate the ability of surface temperature measurement by means of infrared thermometry to rapidly assess large areas of cropped land for plant water potential depressions arising from shortages of soil moisture. (Author's abstract)
W84-04970

SEASONAL DROUGHT RESPONSE OF SELECTED WHEAT CULTIVARS,

Agricultural Research Service, Florence, SC. Coastal Plains Soil and Water Conservation Research Center.
R. E. Sojka, L. H. Stolzy, and R. A. Fischer.

Agronomy Journal, Vol. 73, No. 5, p 838-845, September-October, 1981. 3 Fig, 7 Tab, 32 Ref. Rockafeller Foundation grant RF-72035.

Descriptors: *Wheat, *Water stress, *Drought, *Seasonal variation, Soil water, Water use, Irrigation effects, Crop yield.

Wheat cultivars vary in their response to water stress. There is a high correlation between a cultivar's seasonal plant water status (Psi x) and its yield, which is unique to each cultivar. Plant water status measurements were used to compare the drought response of selected wheat cultivars in a two year field experiment. Yield, xylem pressure potential (Psi x), adaxial leaf diffusive resistance (Rs), and soil water content (Theta) were monitored in 12 cultivars of Triticum aestivum and T. durum, and two of Tritosecale. Genotypes with lower seasonal Psi x generally had higher percent yield reduction, when yield was expressed as a percent of irrigated controls. Water use during the observation period in the second season was similar for all droughted treatments and cultivars (about 17 cm H2O) which was less than half that of the irrigated controls (44 cm H2O). Late in the second season, Psi x decreased to as low as -47 bars in some treatments. Correlation between midday Psi x and yield (absolute or percent of control) for individual cultivars were highly significant. The importance of full night Psi x recovery to near zero was apparent since for three cultivars studied intensively, 80% of the yield difference between nonstressed controls and stressed treatments had already accrued when pre-sunrise Psi x decreased to -7 bars. Further reduction of predawn Psi x to -38 bars was associated with only an additional 20% of the yield loss. The relative insensitivity of flag leaf adaxial diffusive resistance to cultivar differences under stress would seem to rule it out as a screening tool for water stress resistance in cereals. (Moore-IVI)
W84-04971

WATER USE BY FORAGE SPECIES,

Agricultural Research Service, Cheyenne, WY. High Plains Grasslands Research Station.
M. L. Fairbourn.

Agronomy Journal, Vol. 74, No. 1, p 62-66, January-February, 1982. 1 Fig, 3 Tab, 19 Ref.

Descriptors: *Water use efficiency, *Forages, *Grasses, Soil water, Clover, Alfalfa, Vetch, Sainfoin, Evapotranspiration.

Forage production on the High Plains of Western United States might be done more economically if research provided more water-use information for species. A study was made to determine (1) water-use efficiency and (2) ability to use available soil water during a harvest growing period. Forages common to the area were evaluated in both greenhouses and field environments. The legume species evaluated were 'Alsike' clover (Trifolium hybridum). 'Dawson', 'Fremont', 'Ladak', 'Team', 'Travois', and 'Vernal' alfalfa (Medicago sativa L.), 'Lutana' cicer milkvetch (Astragalus cicer L.), and 'Remont' sainfoin (Onobrychis vicaefolia Scop.). Pasture grasses evaluated were 'Fawn' tall fescue (Festuca arundinacea Schreb.), 'Garrison' creeping foxtail (Alopecurus arundinaceus Poir), 'Latar' orchardgrass (Dactylis glomeranta L.), 'Grennar' intermediate wheatgrass (Agropyron intermedium (Host) Beauv. L.), thickspike wheatgrass (A. dasystachyum (Hook) Scribn.) and 'Regar' bromegrass (Bromus biebersteinii Roem and Schult.); while range grasses were blue grama (Bouteloua gracilis (H.B.K.) Lag), crested wheatgrass (Agropyron desertorum (Fisch. ex Link) Schult.), slender wheatgrass (A. trachycaulum (Link) Malte), western wheatgrass (A. smithii Rydb.), and green needlegrass (Stipa viridula Trin.). The study was made on Altvan soil, a fine, sandy, clay loam belonging to the mixed mesic family of aridic arguistolls. Water use was monitored by gravime-

tric method and by tensiometers in the first and second studies, respectively. Transpiration in the greenhouse during a crop growing period ranged from 7.2 cm for the milkvetch to 15.5 cm for Regar bromegrass. Blue grama had the highest water-use efficiency of all species but was able to utilize only a relatively small amount of the available water in forage production. Growing the plants in a field environment increased evapotranspiration by 100 to 200% compared with that in the greenhouse. Thickspike wheatgrass appeared to be capable of adapting to either a semiarid or humid climate but range grasses studied were unable to use large amounts of available water. (Author's abstract)
W84-04975

PLANT RESISTANCE TO WATER FLOW IN FIELD SOYBEANS: I. NON-LIMITING SOIL MOISTURE,
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
J. W. Jones, B. Zur, K. J. Boote, and L. C. Hammond.
Agronomy Journal, Vol. 74, No. 1, p 92-98, January-February, 1982. 6 Fig, 1 Tab, 24 Ref. USDA grant 801-15-58.

Descriptors: *Soybean, *Plant water flow resistance, Transpiration, Soil water potential, Plant water potential.

Predictions of plant water relations and transpiration require estimates of resistances to water flow in the soil and in the plant. A field experiment was conducted to determine plant resistance to water flow under field conditions during two periods of soybean (Glycine max) growth, on Arredondo fine sand (hypothermic, coated Typic Quartzipsamment). Root depth distributions were measured during each growth period and soil water potential distributions were measured daily. Every other day, during the periods 4 to 16 May (Exp. I) and 30 May to 7 June (Exp. II), hourly measurements of leaf water potential and transpiration were used to calculate plant resistance using Ohm's law analogy. Daily plant resistance was calculated using midday leaf water potential and total integrated transpiration for each day. Calculated plant resistance increased with transpiration flux in a nonlinear relationship. When plant resistance values for quasi-steady state conditions during midday hours were examined, they averaged 940 MPa h/sq cm for the first experiment, independent of transpiration flux over a range of 0.02 to 0.05 cm/h. Plant resistance values increased with time and averaged 2,360 MPa h/sq cm for quasi-steady state conditions in the second experiment. Plant resistance values calculated on a daily basis averaged 200 and 300 MPa-day/sq cm for the first and second experiments, respectively, 3 to 5 times higher than plant resistance values based on hourly measurements. Plants are seldom at steady state under natural conditions, and random or average measurements of leaf water potential do not represent the true driving force for water transport through this complex system. (Moore-IVI)
W84-04976

TOTAL RESISTANCE TO WATER FLOW IN FIELD SOYBEANS: II. LIMITING SOIL MOISTURE,
Florida Univ., Gainesville. Dept. of Soil Science.
B. Zur, J. W. Jones, K. J. Boote, and L. C. Hammond.
Agronomy Journal, Vol. 74, No. 1, p 99-105, January-February, 1982. 7 Fig, 2 Tab, 16 Ref. USDA grant 801-15-58.

Descriptors: *Soybean, *Plant water flow resistance, *Soil water flow resistance, Transpiration, Soil water potential, Roots, Permeability coefficient, Plant water potential, Irrigation effects.

Experiments were conducted to determine the total (soil plus plant) resistance to water flow through field grown soybeans (Glycine max (L.) Merr.) subjected to two drying cycles during pod addition and early pod fill (4 to 16 May) and mid-to-late pod fill (30 May to 7 June). Root length density distributions with depth were measured during each drying cycle and soil water potential distributions were measured daily. The experiment was conducted in the field on Arredondo fine sand (hypothermic, coated Typic Quartzipsamments). Transpiration flux and leaf water potential measured hourly every 2 days during each drying cycle were used with daily measurements of soil water potential to calculate total resistance. Midday transpiration rates decreased relative to transpiration rates of irrigated plots starting 8 and 5 days after irrigation for the first and second drying cycles, respectively, when average soil water potential was - 0.04 MPa. The increase in total resistance which corresponds to the decrease in transpiration flux was attributed to increased soil resistance. However, calculated soil resistances based on experimental results were four to six orders of magnitude higher than theoretical calculations of the bulk soil resistances based on the Gardner (1960) model. Calculations of water potential at the root surface during drying conditions indicate that unsaturated hydraulic conductivity of soil adjacent to the root may be several orders of magnitude lower than that of the bulk soil and could explain the observed reduction in the transpiration flux. (Author's abstract)
W84-04977

YIELD, YIELD COMPONENTS, AND NUTRIENT CONTENT OF CORN GRAIN AS INFLUENCED BY POST-SILKING MOISTURE STRESS,
H. J. Harder, R. E. Carlson, and R. H. Shaw.
Agronomy Journal, Vol. 74, No. 2, p 275-278, March-April, 1982. 1 Fig, 3 Tab, 17 Ref.

Descriptors: *Corn, *Water stress, *Crop yield, Irrigation timing, Precipitation, Soil water, Plant physiology, Phosphorus, Potassium.

Sensitivity of corn (Zea mays L.) grain development to moisture stress is related to the physiological stage of development when stress occurs. For this reason the time when moisture stress occurs is important in determining final grain yield; hence, timing of precipitation or irrigation becomes an important economic factor in corn production. The primary objective of this work was to determine the effect of successive, repetitive moisture-stress treatments on yield and yield components. To accomplish this goal, experiments were conducted in the movable rain shelter facility at Ames, Iowa, during the summers of 1976 and 1977. With this facility, different soil-moisture conditions were imposed simultaneously with plants growing under similar conditions of atmospheric demand. Corn plants were grown in containers with 100 liters of a Nicollet loam soil (an Aquic Hapludoll, fine-loamy mixed mesic). Single and multiple periods of moisture stress were imposed after silking in one, two, or three successive stress cycles to study their effect on grain yield and yield components (kernels/plant and mass/kernel). Successive respective stress treatments on the same plants were included to observe plant response to moisture stress after sink size (kernel number) was altered because of previous stress. Grain yield reductions of up to 33% depended primarily upon severity and duration of soil-moisture stress. Additional stress cycles did not always cause an additive reduction in grain yield. Moisture stress that occurred within 2 weeks after silking reduced the number of kernels/plant by about 15% with little influence on final mass/kernel. Additional stress cycles had only minor effects on kernel number. Plants that were stressed shortly after silking and suffered reduction in kernels/plant had shorter, but uniformly filled ears, suggesting that stress-inhibited development of kernels at the tip of the ear. Moisture stress influenced mass/kernel in a complex fashion. Decreases up to 20% were observed. The observed pattern for mass/kernel depended on the timing of stress in relation to silking date and previous moisture-stress history of the plant. Moisture stress increased % N in the grain from 1.7% in controls to 1.8 and 1.9% in one and two repeated stress cycles, respectively, but did not significantly influence % P or % K in the grain at harvest. (Author's abstract)
W84-04978

SALT AND WATER STRESS EFFECTS ON GERMINATION OF GUAYULE SEEDS,
Texas A and M Research and Extension Center, El Paso.
S. Miyamoto, K. Sosnovske, and J. Tipton.
Agronomy Journal, Vol. 74, No. 2, p 303-307, March-April, 1982. 3 Fig, 4 Tab, 6 Ref.

Descriptors: *Guayule, *Germination, *Saline water, *Water stress, *Texas, Saline soils, Irrigation water, Irrigation effects, Specific ion effects.

West Texas is considered one of the key potential guayule producing areas. Guayule (Parthenium argentatum), a rubber producing desert shrub, is native to this region. In cultivating guayule, salinity may pose a problem, since many of the irrigated soils and irrigation waters in this region are affected by salt. Studies were performed to evaluate salt and soil water stress effects on seed germination. The test materials included four USDA selections (11646, 11604, 11633, and A48118) and one cultivar (593). Petri dish solution cultures were used for evaluating salt effects, and two sandy soils (Typic Torrifluvents and Typic Torripsamments) placed in petri dishes were used for studying soil water stress effects. Increasing salt concentrations slowed germination, especially when salt concentrations exceeded 200 meq/l or the electrical conductance of 15 mmho/cm. Seed germination may be reduced by approximately 25%, due to salinity of salt solutions ranging from 7 to 19 mmho/cm with a descending order of tolerance of 11646, 593, 11604 = 11633, and A48118. Selection 11646 showed excellent characteristics as well as high salt tolerance. Specific ion effects were insignificant when tested in salt solutions having mixed ion compositions. Soil water stress needs to be controlled at less than about 0.8 bar if germination is to be accomplished without adverse effects of water stress. Salinity will not be a factor in reducing germination in west Texas, as long as irrigation is performed in such a way that no salt accumulation occurs in the seed zone. (Moore-IVI)
W84-04979

COMPARISON OF WATER STRESS OF COTTON FROM MEASUREMENTS WITH THE HYDRAULIC PRESS AND THE PRESSURE CHAMBER,
California Univ., Davis. Dept. of Land, Air and Water Resources.
R. A. Radulovich, C. J. Phene, K. R. Davis, and J. R. Brownell.
Agronomy Journal, Vol. 74, No. 2, p 383-385, March-April, 1982. 1 Fig, 1 Tab, 11 Ref.

Descriptors: *Cotton, *Water stress, *Hydraulic press, *Pressure chamber, Plant water potential, Irrigation scheduling, Measurement instrumentation.

The pressure chamber (PC) technique for the determination of leaf water potential has become universally accepted, but the hydraulic press (HP) technique for the estimation of plant water status has some advantages over the PC technique. Measurements of water status of cotton obtained with the HP and the PC were compared and correlated in replicated experiments under greenhouse and field conditions. The HP could very well replace the PC for green house applications. In field experiments, the HP does not measure low water potential accurately below -940 kPa as determined by the PC. With cotton, the most representative endpoint to use with the HP is the pressure at which water exudes from the cut edge of a tip of an uppermost fully expanded leaf. The HP can be used advantageously for irrigation scheduling of cotton if the threshold value is -940 kPa or higher, as determined when the highest water potential values for a day are found (i.e., predawn). The inability of the HP to estimate low water potentials of cotton leaves, under these conditions, seems to be a serious limitation of the instrument. (Moore-IVI)
W84-04981

INTERRELATIONSHIPS OF IRRIGATION FREQUENCY, UREA NITROGEN, AND

GYPSUM ON FORAGE SORGHUM GROWTH ON A SALINE SODIC CLAY SOIL,
M. A. Mustafa, and E. A. Abdelmagid.
Agronomy Journal, Vol. 74, No. 3, p 447-451, May-June, 1982. 6 Tab, 19 Ref.

Descriptors: *Irrigation frequency, *Sorghum, *Saline soils, *Gypsum, *Fertilizers, Forages, Plant growth, Nitrogen, Semiarid lands, Crop yield, Evaporation, Germination, Water use efficiency.

Two field experiments were conducted in June, 1978, and April, 1979, at the Khartoum University Farm, Sudan, to study the effect of irrigation frequency, urea-nitrogen, and gypsum on the yield of forage sorghum (Sorghum vulgare L.) grown on a semi-arid, saline-sodic clay soil. Each experiment had four nitrogen levels: 0N, 1N, 2N, and 3N (1N = 43.8 kg N/ha) applied as urea; three irrigation frequencies; 7, 10, and 15 days; and zero or 11.9 tonnes/ha gypsum, each replicated thrice in a split-split plot design. The seasonal quantity of water applied was the same for all frequencies of irrigation and was slightly higher than evaporation from a U.S. class A pan. The two seasons data consistently showed that dry matter yield of the first cuts of forage sorghum increased significantly with increase in N-level, with decrease in irrigation interval, and with gypsum application. Decreased irrigation frequency had greater effect than 3N fertilization. The benefits from gypsum application were low (5%) at the 7-day irrigation interval. Dry matter yields were increased from 1.84 to 6.12 tonnes/ha in 1978 and from 3.20 to 7.23 tonnes/ha in 1979, by irrigating every 7 days instead of 15 days, application of 3N and 11.9 tonnes/ha gypsum. Plant height and leaf area index increased with N fertilization, with gypsum and with reduction of irrigation interval from 15 to 7 days, whereas germination percentage was significantly increased by gypsum only. Dry matter yield significantly correlated (P = 0.01) with leaf area index and plant height but not with germination percentage. Multiple regression analysis showed that the first two growth attributes accounted for about 87% of the variability of yield. The dry matter yields of the second cuts were similarly affected by treatments but were about one-half to one-third those of the first cuts in 1978 and 1979 seasons, respectively. For the two seasons the average seasonal water-use was about 1.02 times that of the U.S. class A pan evaporation. Water-use efficiency increased from 15.6 to 43.9 kg/ha-cm in 1978 and from 19.1 to 51.2 kg/ha-cm in 1979, by irrigating every 7 days instead of 15 days, and applying 3N urea and 11.9 tonnes/ha gypsum. (Author's abstract)
W84-04984

EFFECTS OF PLANT AND ROW SPACING ON DRYLAND SOYBEAN YIELD AND WATER-USE EFFICIENCY,
Science and Education Administration, Mandan, ND. Northern Great Plains Research Center.
For primary bibliographic entry see Field 3F.
W84-04990

RESPONSE OF DRIP-IRRIGATED SUGARCANE TO DROUGHT STRESS,
Lihue Plantation Co. Ltd., Kauai, HI.
For primary bibliographic entry see Field 3F.
W84-04991

EFFECT OF CROP RESIDUE MANAGEMENT AND TILLAGE ON WATER USE EFFICIENCY AND YIELD OF WINTER WHEAT,
Agricultural Research Service, Pullman, WA.
For primary bibliographic entry see Field 3F.
W84-04992

EFFECT OF IRRIGATION AND ROW SPACING ON SOYBEAN WATER USE,
Agricultural Research Service, Morris, MN.
For primary bibliographic entry see Field 3F.
W84-04995

DROUGHT RESPONSE OF SORGHUM HYBRIDS UNDER A SPRINKLER IRRIGATION GRADIENT SYSTEM,
Arizona Univ., Tucson.
For primary bibliographic entry see Field 3F.
W84-04999

YIELD AND YIELD COMPONENTS OF 'BRAXTON' SOYBEANS AS INFLUENCED BY IRRIGATION AND INTRAROW SPACING,
Clemson Univ., SC. Dept. of Agronomy and Soils.
For primary bibliographic entry see Field 3F.
W84-05002

WATER STRESS STATUS IN GUAYULE AS MEASURED BY RELATIVE LEAF WATER CONTENT,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 3F.
W84-05009

WATER STRESS, GROWTH, AND CRITICAL WATER POTENTIALS OF RABBITEYE BLUEBERRY (VACCINIUM ASHEI READE),
Florida Univ., Gainesville. Dept. of Fruit Crops.
F. S. Davies, and C. R. Johnson.
Journal American Society of Horticultural Science, Vol. 107, No. 1, p 6-8, 1982. 2 Fig, 1 Tab, 18 Ref.

Descriptors: *Water potentials, *Water stress, *Blueberry, Stress, Plant growth, Critical water potentials, Crop yield, Transpiration.

The relationship between critical water potential and relative water content (RWC) to rabbiteye blueberry drought-tolerance was investigated as well as the effects of moderate and severe water-stress on growth of containerized rabbiteye blueberry plants. Growth, expressed as leaf area and root, stem and leaf dry weights, was decreased significantly by both moderate and severe water-stress. The root:shoot ratio was not altered significantly by water-stress, indicating that growth of roots and shoots was balanced even during water deficits. Critical water potential for stomatal closure was -2.2MPa, transpiration ratio averaged 222 g of water transpired per g dry matter produced and relative water content changed 6.4% per 1.0 MPa change in water potential. (Baker-IVI)
W84-05059

WATER RELATIONS OF WELL-WATERED, MYCORRHIZAL, AND NON-MYCORRHIZAL ONION PLANTS,
Michigan State Univ., East Lansing. Dept. of Botany and Plant Pathology.
C. E. Nelson, and G. R. Safir.
Journal of the American Society of Horticultural Science, Vol. 107, No. 2, p 271-274, 1982. 2 Fig, 19 Ref.

Descriptors: *Phosphorus, *Permeability, *Plant water potentials, *Onions, Mycorrhizal fungi, Nutrients, Soil properties, Leaves, Water potentials, Phosphorus, Roots.

The water relations of mycorrhizal onions were compared with those of non-mycorrhizal controls grown under low and high soil phosphorus conditions. Mycorrhizal plants had higher leaf water potentials, higher transpiration rates, higher hydraulic conductivities and lower leaf resistances than did non-mycorrhizal plants grown in low soil phosphorus conditions. When controls were grown under high soil phosphorus conditions, the measured parameters were not different from those of mycorrhizal plants. The magnitude of the effect of mycorrhizal fungi on the water relations of the host may, in part, be a function of phosphorus nutrition. The fact that added phosphorus affects the water relations of the onion in the same way that the mycorrhizal fungus does suggests that the primary cause of the changes is nutritional. A model root system has been suggested where changes in membrane permeability can have large effects on root resistance to water flow. This may explain the effects of mycorrhizae on hydraulic conductivity. The differences in leaf water potentials, transpiration rates and leaf resistance are considered to be the result of the differences found in hydraulic conductivities. (Baker-IVI)
W84-05060

WATER STRESS EFFECTS ON PICKING CUCUMBER,
Ohio Agricultural Research and Development Center, Wooster. Dept. of Horticulture.
D. G. Ortega, and D. W. Kretchman.
Journal of the American Society of Horticultural Sciences, Vol. 107, No. 3, p 409-412, 1982. 2 Fig, 5 Tab, 22 Ref.

Descriptors: *Plant growth, *Water stress, *Cucumbers, Crop yield, Water potentials, Leaves, Plant water potential, Fruit.

The peculiar growth patterns of cucumbers were examined along with the causes for the differences in fruit growth and plant development due to water stress. Seven days after treatment initiation, vine length of the non-stressed plants had increased an average of 11 cm, while the stressed plants had increased 2 cm. Two weeks after treatment initiation, vine length of the control plants had increased an average of 13 cm, while stressed plants had ceased to grow. Plant node number was affected to a lesser extent by water stress. Node number on stress plants was significantly less only at 14 days after treatment initiation. Fruit growth rate of non-stressed plants was initially high and decreased with time. Rate of length increase was greater than diameter rate but declined to a similar level of increase. Growth rates of fruit on stressed plants were much less than those of non-stressed plants. Osmotic and water potentials of fruits and leaves were determined 1 week after treatment initiation. Osmotic potentials for the stressed fruits and leaves were generally lower than for their non-stressed counterparts. Large stressed fruits possess the ability to prevent large decreases in water content despite a decrease in water potential, an action which favors survival during stress. This characteristic is probably due to fruit osmotic adjustment in which there is an increase in solute content per cell without a decrease in water content. (Baker-IVI)
W84-05061

RESPONSE OF SQUASH TO IRRIGATION, NITROGEN FERTILIZATION, AND TILLAGE SYSTEMS,
Georgia Coastal Plain Experiment Station, Tifton.
D. A. Smittle, and E. D. Threadgill.
Journal of the American Society of Horticultural Science, Vol. 107, No. 3, p 437-440, 1982. 4 Fig, 2 Tab, 14 Ref.

Descriptors: *Irrigation practices, *Crop yield, *Squash, *Tillage, Fertilization, Nitrogen, Water conservation, Moisture tension.

The response of squash to combinations of irrigation, N fertilization and tillage methods was investigated. Dixie squash were subjected to factorial combinations of 2 irrigation levels, 4 N treatments, and 3 tillage methods on a Lakeland sand soil during 1978, 1979, and 1980. The greatest marketable fruit yield resulted from a combination of applying irrigation at 0.3 bar soil water tension, applying 2.5 kg N/ha through the irrigation system at 2, 3, 4, 5, and 6 weeks after planting, and preparing the seedbed by moldboard plow tillage. Yields were reduced 3 to 16% by either reducing the N rate, allowing a greater soil water tension before irrigation, or by the use of subsoil-bed or disk-harrow tillage system. A combination of subsoil-bed tillage and application of irrigation at 0.6 bar soil water tension resulted in the greatest yield when squash received a single N application after planting. Squash yield was reduced 13% when irrigated at 0.3 bar with subsoil-bed tillage. Yields of squash irrigated at 0.6 bar soil water tension were 12% and 37% lower with moldboard plow and disk than with subsoil-bed tillage. (Baker-IVI)
W84-05062

RAPID METHOD TO ESTIMATE FRUIT WATER STATUS WITH SPECIAL REFERENCE TO RAIN CRACKING OF SWEET CHERRIES,
Oregon State Univ., Corvallis. Dept. of Horticulture.
P. C. Anderson, and D. G. Richardson.
Journal of the American Society of Horticultural Science, Vol. 107, No. 3, p 441-444, 1982. 3 Fig, 2 Tab, 25 Ref.

Descriptors: *Fruit crops, *Water potentials, *Cherries, *Rain cracking, Cracking, Osmotic pressure, Turgor, Soluble solids.

A technique is described whereby osmotic potential, turgor potential and total fruit water potential can be determined quickly in the field with the aid of a pressure bomb, a hand held refractometer, and a percent soluble solids to osmotic potential conversion chart. A unique inverse linear relationship between percent soluble solids and osmotic potential was found for each fruit species examined. A calibration curve was compiled relating percent soluble solids by refractometry and osmotic potentials by psychrometry. Turgor pressure was obtained by subtracting the osmotic equivalent of percent soluble solids from total fruit water potential determined by a pressure chamber apparatus. Therefore, total, osmotic and turgor potentials can be determined in the field in a matter of minutes. The technique when applied to rain cracking of Napoleon sweet cherries provided additional evidence that rain cracking is not a direct function of percent soluble solids, osmotic potential, turgor potential or fruit water potential. (Baker-IVI)
W84-05063

EFFECTS OF RAINFALL AND IRRIGATION MANAGEMENT ON CITRUS JUICE QUALITY IN TEXAS,
Agricultural Research Service, Weslaco, TX.
R. R. Cruse, C. L. Wiegand, and W. A. Swanson.
Journal of the American Society of Horticultural Science, Vol. 107. No. 5, p 767-770, 1982. 3 Tab, 15 Ref.

Descriptors: *Irrigation practices, *Fruit crops, Oranges, Grapefruit, Crop yield, Water stress, Irrigation, Plant growth.

Four different irrigation regimes were tested on 2 sizes of Marrs and Valencia oranges, and on Citrus sinensis Osbeck and Ruby Red grapefruit. The fruit was examined for juice yield, degrees Brix (soluble solids), citric acid, suspended solids, L-ascorbic acid (Vitamin C), pH, and naringin content. In the area of study, natural rainfall contributes about half the annual water requirement to the plants. In Marrs oranges the only juice characteristic affected with any consistency was soluble solids. Brix decreased with increasing water availability to trees. Vitamin C content was significantly higher in the wettest treatment in 1973, which was also a year of high rainfall. In grapefruit, pH, Vitamin C, juice yield, and suspended solids were only infrequently affected by combined irrigation and rainfall. In Valencia oranges, the juice yield of size 125 was affected by irrigation treatments in 4 of the 6 years, whereas the juice yield of size 200 was affected in only 2 of the 7 test years. The most consistent effects over the years of the study of irrigation treatments occurred in the Marrs orange, where in all cases of significance, the juice attributes decreased in value in the order of increasing frequency of irrigation. (Baker-IVI)
W84-05064

EFFECT OF SOIL MOISTURE STRESS TO VARIOUS FRACTIONS OF THE ROOT SYSTEM ON TRANSPIRATION, PHOTOSYNTHESIS, AND INTERNAL WATER RELATIONS OF PEACH SEEDLINGS,
Department of Agriculture, Harrow (Ontario). Research Station.
For primary bibliographic entry see Field 2D.
W84-05065

EFFECT OF REDUCED WATER SUPPLY ON PEACH TREE GROWTH AND YIELDS,
Victoria Dept. of Agriculture, Tatura (Australia). Irrigation Research Inst.
For primary bibliographic entry see Field 3F.
W84-05066

WATER RELATIONS AND FROND CURL OF CUT LEATHERLEAF FERN,
Florida Univ., Gainesville. Dept. of Ornamental Horticulture.
T. A. Nell, J. E. Barrett, and R. H. Stamps.
Journal of the American Society of Horticultural Science, Vol. 108, No. 4, p 516-519, 1983. 3 Fig, 2 Tab, 15 Ref.

Descriptors: *Ferns, *Water potential, *Fronds, Stomata, Postharvest, Dessication, Water uptake.

Leatherleaf fern (Rumohra adiantiformis (G. Forst) Ching) fronds became desiccated rapidly after harvest with water potential decreasing from -0.45 to -1.75 MPa within 30 minutes. Partial closing of stomates 30 minutes after harvest accounted for a decrease in the rate of frond desiccation and frond water potential was -2.26 MPa after 180 minutes. Postharvest frond desiccation to water potentials of -1, -2, and -3 MPa in the field prior to water dip and cold storage resulted in frond curl of 32, 56, and 84%, respectively, when placed in postharvest rooms. Water uptake decreased during the first 4 days in postharvest rooms. Declining frond water potentials suggested reduced rate of water uptake was due to blockage of the xylem. However, no obstructions were observed at cut end of stipe from fern with frond curl or those not exhibiting frond curl. Frond water potentials were lower one hour after harvest than when undergoing normal postharvest senescence. Fronds did not exhibit normal drought-imposed wilt or frond curl during prestorage stress. Desiccation resulted in frond curl in some experiments but had little effect in others. These results indicate that frond curl can be triggered by desiccation stress but other factors are predisposing fronds to this disorder. (Author's abstract)
W84-05070

WATER RELATIONS AND GROWTH OF SNAP BEANS AS INFLUENCED BY DIFFERENTIAL IRRIGATION,
Oregon State Univ., Corvallis. Dept. of Horticulture.
For primary bibliographic entry see Field 3F.
W84-05074

EFFECT OF NITROGEN RATE AND WATER STRESS ON GROWTH AND WATER RELATIONS OF YOUNG SWEET CORN PLANTS,
Cook Coll., New Brunswick, NJ. Dept. of Horticulture and Forestry.
A. J. Tesha, and P. Eck.
Journal of the American Society of Horticultural Science, Vol. 108, No. 6, p 1049-1053, 1983. 6 Fig, 20 Ref.

Descriptors: *Corn, *Water stress, *Nitrogen, Stomata, Chlorophyll, Drought resistance, Water potential, Water content.

Seedlings of sweet corn (Zea mays L. cv. Iochief) were grown in sand with 3 rates of N at a moderate and severe water-stress rate produced by adding polyethylene glycol (PEG 6000) to the nutrient solution. As water stress increased, dry-matter production decreased. Increasing N rate compensated in part for the loss in dry-matter production that resulted from the water stress. Leaf chlorophyll levels and stomatal density on the abaxial leaf surface increased with an increase in N, and a faster recovery of the relative water content of leaf tissue following water-stress treatment occurred. All 3 responses could have contributed to the N response in dry-matter production observed at the 2 water-stress levels. A low N rate may aid young sweet corn seedlings under severe water stress to resist drought, as indicated by a stabilization in dry-matter production in plants receiving only 8 mM N in the nutrient solution when moving from moderate to severe water stress. These plants had a higher relative water content and leaf water potential under severe water stress than plants receiving higher rates of N, which may have contributed to the ability of plants receiving a low-N rate to cope with the severe water stress. (Author's abstract)
W84-05075

LEAF CONDUCTANCE, GROWTH AND SURVIVAL OF WILLOW AND DECIDUOUS FRUIT TREE SPECIES UNDER FLOODED SOIL CONDITIONS,
Oregon State Univ., Corvallis. Dept. of Horticulture.
P. C. Andersen, P. B. Lombard, and M. N. Westwood.
Journal of the American Society of Horticultural Science, Vol. 109, No. 2, p 132-138, 1984. 6 Fig, 4 Tab, 29 Ref.

Descriptors: *Trees, *Flood tolerance, Leaf conductance, Plant growth, Apple, Pear, Quince, Peaches, Willow, Abscission, Soil oxygen diffusion, Adventitious rooting, Chlorosis.

Potted seedlings and cuttings of various tree species were submerged to 5-10 cm above the soil level for up to 20 months in order to determine flood tolerance based on leaf conductance (kl), growth, and survival. Flooding induced a decline in kl at soil oxygen diffusion rates of 30, 22, 20, and 15 x 10 to the -8 g/sq cm/min for Prunus persica (L.) Batsch, Halford seedlings (peach), Pyrus communis L. cv. Bartlett (Bart), Pyrus calleryana Decne (Call), and Pyrus betulaefolia Bunge (Bet), respectively. The leaves of some species, particularly Pyrus communis L. cv. Old Home x Farmingdale 97 (OH x F 97), abscised shortly after a decline in kl, yet leaves of most other Pyrus species did not abscise despite months of maintaining a kl near zero. Growth rates were reduced for all fruit tree species except Bet and Call after one month of spring flooding. One month of fall flooding reduced the growth of all fruit tree species the following spring. Bet survived 20 months of continuous submergence; however, only Salix discolor Muhl. (willow) grew well under these conditions. Flooding promoted adventitious rooting of willow, Cydonia oblonga Mill. cv. Provence Ba 29 (quince) and Malus domestica Borkh. cv. MM 106 (apple); anthocyanin pigmentation in leaves of apple and all Pyrus species; leaf chlorosis of quince, apple, and peach; and hypertrophied lenticels on the submerged stems and roots of all species. The tolerance, based upon kl, growth, and survival, was: willow > Bet > Call = quince > Bart > OH x F 97 = Pyrus pyrifolia (Burm.) Nak. (Pyri) = Pyrus ussuriensis Maxim, (Ussuri) = apple > peach. Although the survival of pear rootstocks with and without a 'Bartlett' scion were similar, flooding symptoms often were quite different. (Author's abstract)
W84-05076

MODELING OF DROUGHT RHIZOGENESIS (MODELISATION DE LA RHIZOGENESE DE SECHERESSE),
Paris-11 Univ., Orsay (France).
N. Vartanian, and E. Lesquoy.
Acta Oecologica, Serie Oecologica Generalis, Vol. 5, No. 1, p 3-20, 1984. 8 Fig, 3 Tab, 18 Ref.

Descriptors: *Model studies, *Drought resistance, *Rhizogenesis, Water deficit, Drought rhizigenesis, Soil-water-plant relationship, Random threshold model, Water stress, Data transformation.

In an attempt to model physiological processes involved in adaptive strategy to water deficits, the present study proposes a model to describe the kinetics of drought rhizogenesis in the annual mesophytic species Sinapis alba. This model is based upon the hypothesis of a threshold water potential value in the soil-plant system for the initiation of drought rhizogenesis. It supposes that each plant produces short roots in one or two days and that the variability between plants consists in the randomness of both the date of short roots initiation and the number of short roots produced. A sigmoidal response curve is obtained to describe the expected number of short roots. This curve represents the cumulative distribution function of the random date, multiplied by the expected number of short roots. Data are transformed in order to stabi-

lize the variance and the model is used to compare two irradiance levels and two different genotypes. (Author's abstract)
W84-05285

2J. Erosion and Sedimentation

COHESIVE MATERIAL EROSION BY UNIDIRECTIONAL CURRENT,
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
J. W. Kamphuis, and K. R. Hall.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p 49-61, January, 1983. 10 Fig, 1 Tab, 31 Ref.

Descriptors: *Erosion, *Unidirectional flow, Current, Sediment transport, Cohesive soils, Shear stress, Clay, Plasticity, Velocity.

The initiation of motion of consolidated cohesive sediments under a unidirectional flow of clear water was studied. Experiments were performed in a flume-tunnel capable of providing a bed shear stress up to 26 Pa and a velocity of 3.5 m/s, 3 mm above the bed. The variation of critical shear stress with unconfined compressive strength and vane shear strength was linear. The capability of a cohesive soil to resist erosion increases with clay content and plasticity index. The size of the eroded pieces tends to be larger for a soil with a low clay content. The shear stress required to initiate erosion of a cohesive soil increases with consolidation pressure. Once the critical shear stress for a soil is reached, erosion progresses immediately, that is, there is little or no dependence on the previous time history of the flow. Once the initial clay surface has been altered, erosion progresses at a more rapid rate due to an increase in hydrodynamic roughness at the soil surface. A useful experimental facility to study the erosion of cohesive soil has been developed. Soil samples can be preconsolidated up to presssures of 1,000 kPa in a relatively short period of time (2-7 days) using the soil press apparatus. The consolidation range of the soil press plus a maximum erosion velocity 3 mm above the bed of 3.5 m/s in the flume-tunnel enables duplication of most field conditions. Since no general purpose empirical formulations exist to predict the susceptibiltiy of a cohesive soil to erosion, and since prototype underwater tests are expensive, model tests can provide valuable information. A large number of physicochemical factors influence the resistance of a cohesive soil to erosion and, therefore, the model test should simulate the naturally occurring conditions as accurately as possible. This means that in situ soil should be used, the effects of remolding should be determined, and fluid conditions of the prototype should be simulated. (Baker-IVI).
W84-04822

SEDIMENT YIELDS IN COASTAL SOUTHERN CALIFORNIA,
California Inst. of Tech., Pasadena.
B. D. Taylor.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p 71-85, January, 1983. 4 Fig, 2 Tab, 8 Ref.

Descriptors: *Sediment yield, *California, *Coastal plains, California shoreline, Sediment discharge, Sediment distribution, Sediment transport, Sedimentary basins, Sedimentation, Deposition, Sedimentation basins, Sand, Erosion, Performance evaluation.

Of the 33,000 sq km of coastal drainage in southern California between Point Conception and the US-Mexico border, approximately four-fifths is erosional according to recent geological history. Ninety-four percent of the erosional area debouchs water and sediment into intermediate depositional areas before reaching the coast, with the remaining 6% (smaller coastal streams) draining directly to the shore line. In southern California the delivery of inland sediments to the coast is important for shoreline stability and the preservation of natural beach areas. During the past several decades, changes in land use and the construction of water conservation and flood control structures have materially affected natural sediment movements and coastal deliveries. To provide a basis for regional sediment management, a study has been undertaken at the California Institute of Technology to quantify natural sediment movements and man's effect on these processes. As a first step in this study, sediment yields from inland areas have been estimated. Results indicate that an annual average of 12 million cu m of sedimentary material are yielded from geologically erosional areas. Of this, 6 million cu m are fine sediments, 5 million cu m are sand, and 0.8 million cu m are coarser than 2 mm. (Murphy-IVI)
W84-04824

UNSTEADY TRANSPORT OF SUSPENDED LOAD AT SMALL CONCENTRATIONS,
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
P. N. Lin, J. Huan, and X. Li.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p 86-98, January, 1983. 6 Fig, 1 Tab, 8 Ref.

Descriptors: *Sediment transport, *Suspended sediments, *Mathematical models, Estuaries, Routing, Simulation, Particle size, Sediment load, Qiantang estuary, China, Mathematical equations, Performance evaluation.

Sediment carried by tidal flow in many estuaries on erodible coasts may be so fine that suspension becomes the predominant mode of sediment transport. In this case, morphological changes in the estuary are controlled by the unsteady transport of suspended load carried by the currents. Simulation of the unsteady transport of sediment is obviously of great practical value to an estuary of this kind. When suspension is the predominant mode of sediment transport, an expression for the rate of bed changes may be introduced. This equation together with the momentum equation and the continuity equations of water and sediment constitute a set of four equations for four unknowns. Characteristic directions can then be determined without solving a high-degree algebraic equation. The solution is further simplified by adopting a small-concentration approximation. Routing of suspended load with this method is applied to the Qiantang Estuary in Eastern China and rather close simulation has been achieved. (Murphy-IVI)
W84-04825

OVERLAND FLOW, SEDIMENT OUTPUT AND NUTRIENT LOSS FROM CERTAIN FORESTED SITES IN THE CENTRAL HIMALAYA, INDIA,
Kumaun Univ., Naini Tal (India). Dept. of Botany.
P. C. Pathak, A. N. Pandey, and J. S. Singh.
Journal of Hydrology, Vol. 71, No. 3/4, p 239-251, March, 1984. 7 Tab, 25 Ref.

Descriptors: *Surface flow, *Sediment yield, *Nutrient removal, *Forests, *Himalaya, *India, Sediment erosion, Cycling nutrients, Chemistry of precipitation.

The rainfall characteristics and hydrologic responses of the Himalayan forested catchments are relatively unknown. Evaluation of hydrologic components and nutrient fluxes is prerequisite to understanding the watershed ecosystems and management implications. Overland flow, sediment output, input and output of precipitation nutrients were evaluated on six forested sites in the central Himalaya during the 1981 and 1982 monsoon seasons. Overland flow was significantly different across the forests and the months of the rainy season. It was positively related with rainfall quantity and intensity, and was negatively related with tree canopy cover and with ground vegetation cover. Average overland flow was only 0.66% of the total incident rainfall, indicating that these sites are subsurface-flow systems. Sediment output was positively related to overland flow. Rainfall added a significant amount of nutrients to the forests. This extra-system input was greater than loss through overland flow + sediment output. The loss of nutrients from the forested sites was in the order: Mg > C > Ca > K = N = P. (Murphy-IVI)
W84-04862

ENRICHMENT OF TRANSPORTED SEDIMENTS WITH ORGANIC CARBON, NUTRIENTS, AND CLAY,
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
Y. Avnimelech, and J. R. McHenry.
Soil Science Society of America Journal, Vol. 48, No. 2, p 259-266, March-April, 1984. 22 Fig, 7 Tab, 17 Ref.

Descriptors: *Nutrients, *Organic carbon, *Sediment transport, Nitrogen, Phosphorus, Enrichment ratio, Sediment yield, Sediment-carrying capacity, Sedimentation rates, Erosion, Soil properties, Particle size, Clay.

Much of the nutrient inflow into impoundments is the result of erosion of soil particles on the watershed, together with adsorbed nutrients and their movement from the upland watershed soils. As the detached particles move downstream, they undergo selective size segregation and the nutrients are subject to selective desorption and adsorption between the particles and the water. During transport an enrichment of clay sized particles and the water. During transport an enrichment of clay sized particles within the system occurs as well as that of P, N, and organic C. The ratio of the concentration of any given component in the eroded material system to that in the contributing soils is defined as the enrichment ratio. The selectivity of the erosional and sediment delivery process involved in the transfer of eroded materials from watersheds to lakes or reservoirs is assumed to be proportional to the time, or distance, of travel. This study compares the composition of the eroded material at the onset and at the termination of the erosion, or sedimentation, cycle. From this information insight into the mechanisms affecting the compositional changes along the erosional route may be obtained. Organic carbon, total nitrogen, and total phosphorus concentrations and clay contents in sediments from 41 impoundments or lakes were compared with the equivalent parameters in the soils of the contributing watersheds. The enrichment ratio of a given component (S/S sub o the concentration of the component in the eroded material divided by its concentration in the soil) was theoretically predicted to be: S/S sub o = 1/S sub o x L, where L is a limiting value representing a stable level of this component in the erosion sequence. The measured enrichment ratios for organic C and total N were in good agreement with the theoretical model, the stable levels being 24 and 1.7 g/kg for organic C and total N. No such agreement was found for P and clay enrichment ratios, possibly due to the effect of the variable flow conditions on the selective erosion of these compounds. (Author's abstract)
W84-04874

SOIL LOSS REDUCTIONS FROM CONSERVATION TILLAGE PRACTICES,
Universidade Federal do Rio Grande do Sul, Porto Alegre (Brazil).
N. P. Cogo, W. C. Moldenhauer, and G. R. Foster.
Soil Science Society of America Journal, Vol. 48, No. 2, p 368-373, March-April, 1984. 7 Tab, 18 Ref.

Descriptors: *Soil erosion, *Conservation tillage, *Soil management, Erosion control, Mulches, Martinsville loam, Hapludalfs, Russell silt loam soil, Simulated rainfall, Soil conservation.

Conservation tillage practices are the least costly and least disruptive of the presently available erosion control systems, and in many cases lead to a very significant saving in energy and other expenses. Soil loss reductions by residue cover (mulch) under field conditions were verified by deriving a mulch factor for no-till, chisel plowing plus disking, and spring sweep tillage using anchored and unanchored corn (Zea mays L.) and soybean (Glycine max (L.) Merr.) residues on a 4.5% slope 10.5 m long on Russell silt loam soil. A mulch factor was also derived for sweep tillage using anchored wheat residue on a 6.5% slope Martinsville loam soil, for simulated slope lengths of 35, 60, 85, 110, and 135 m. Both soils are Typic Hapludalfs. The studies were conducted using sim-

ulated rainfall and field plots. A crop residue mulch was relatively more effective than roughness alone in reducing soil loss on smoother soil surfaces and on the longer slopes. Corn residue was more effective in reducing erosion than soybean residue, and residues partially incorporated into the soil were more effective in reducing soil loss than residues loose on the surface. The findings showed that the b-value in the mulch factor (Fm)-% residue cover (M) equation Fm = e to the negative bM power varied appreciably depending on roughness, and type and incorporation of the residue. (Murphy-IVI)
W84-04878

SEDIMENTATION CLOSE TO A NEAR VERTICAL ROCKY WALL IN BALSFJORDEN, NORTHERN NORWAY,
Tromsoe Univ. (Norway). Dept. of Marine Biology.
B. Gulliksen.
Sarsia, Vol. 67, No. 1, p 21-27, 1982. 9 Fig, 32 Ref.

Descriptors: *Sedimentation, *Vertical wall, *Geomorphology, *Galsfjorden, *Norway, Sedimentation rates, Sediment yield, Ecological effects, Phytoplankton blooms, Carbon, Nitrogen, Nutrients.

The rate of sedimentation and the amount of sediment accumulating on the bottom are amoung physical factors of importance for the distribution and abundance of marine benthic organisms. Rates of sedimentation were investigated using collecting jars. Jars suspended at 5, 10, 20, and 30 m depth from October 1976 to November 1977 indicated an increasing sedimentation with depth. The rate of sedimentation exhibited seasonal fluctuations with highest values during spring and summer. At 5 and 10 m depth, maxima in spring and summer corresponded with phytoplankton blooms while maxima at 20 and 30 m were more spread through the summer months. Sedimentation rates and carbon/nitrogen (C/N) ratios were calculated. The mean C/N ratios of sedimented material after acidification were usually below 10:1 from April to October/November in 1977. The highest values of C/N were recorded in February and the early part of March. The amount of resuspended material collected in the jars decreased with distance from the rocky wall. (Murphy-IVI)
W84-04903

PARTICLE SIZE DISTRIBUTION AND NATURAL COAGULATION IN LAKE ZURICH (PARTIKELGROSSENVERTEILUNG UND NATURLICHE KOAGULATION IM ZURICHSEE),
Institut fuer Gewaesserschutz und Wassertechnologie, Zurich (Switzerland).
For primary bibliographic entry see Field 2F.
W84-04919

TIMBER HARVESTING AND FLOODING,
Plum Creek Timber Co., Inc., Missoula, MT.
For primary bibliographic entry see Field 4C.
W84-05056

CONJUNCTIVE USE OF DETERMINISTIC AND STOCHASTIC MODELS FOR PREDICTING SEDIMENT STORAGE IN LARGE RESERVOIRS; 1. A STOCHASTIC SEDIMENT STORAGE MODEL,
Pontificia Univ. Catolica do Rio de Janeiro (Brazil).
For primary bibliographic entry see Field 8A.
W84-05127

CONJUNCTIVE USE OF DETERMINISTIC AND STOCHASTIC MODELS FOR PREDICTING SEDIMENT STORAGE IN LARGE RESERVOIRS: 2. DETERMINISTIC MODEL FOR THE SEDIMENT DEPOSITION PROCESS,
Pontificia Univ. Catolica do Rio de Janeiro (Brazil).
For primary bibliographic entry see Field 8A.
W84-05128

CONJUNCTIVE USE OF DETERMINISTIC AND STOCHASTIC MODELS FOR PREDICTING SEDIMENT STORAGE IN LARGE RESERVOIRS; 3. APPLICATION OF THE TWO MODELS IN CONJUNCTION,
Pontificia Univ. Catolica do Rio de Janeiro (Brazil).
For primary bibliographic entry see Field 8A.
W84-05129

EFFECT OF EROSION ON SOLUTE PICKUP FROM MANCOS SHALE HILLSLOPES, COLORADO, U.S.A.,
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Geography.
J. B. Laronne, and H. W. Shen.
Journal of Hydrology, Vol. 59, No. 1-2, p 189-207, October, 1982. 9 Fig, 3 Tab, 30 Ref.

Descriptors: *Soil erosion, *Solute transport, *Mancos Shale, *Colorado, Shales, Runoff, Rainfall-runoff relationships, Salinity, Surface runoff, Sediment yield, Rill erosion.

Sediment concentration has been shown to be statistically related to solute concentration. A causal relationship is demonstrated between these water quality variables. Solute concentration, which for a constant discharge is linearly related to solute production, increases with increases in sediment yield during rilling and rill entrenchment due to dissolution of transported sediment particles. Moreover, solute release increased as the power per unit width of surface area increased, thereby causally explaining the high correlation between runoff salinity and slope inclination. The regression between these two variables may be used as a tool to assess salinity hazard. The proportions of solute yield derived entirely from contact with the soil surface or from dissolution of transported sediment have not been determined. It is assumed that a significantly larger proportion of solute yield from Mancos Shale hillslopes originates from transported sediment than that demonstrated herein. Direct runoff rather than rainfall induced runoff was generated on the studied hillslopes. (Baker-IVI)
W84-05135

ASSESSMENT OF 210PB DATA FROM SITES WITH VARYING SEDIMENT ACCUMULATION RATES,
Liverpool Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
P. G. Appleby, and F. Oldfield.
Hydrobiologia, Vol. 103, p 29-35, July, 1983. 3 Fig, 1 Tab, 19 Ref.

Descriptors: *Paleolimnology, *Radioactive dating, Dating, Lead, Sediments, Lake sediments, Sedimentation.

The principle assumptions used in Pb-210 chronology are outlined and techniques are presented for assessing the consistency of data with these assumptions. No single model exists that will give a reliable Pb-210 chronology in all cases, and each data set must be evaluated independently for consistency with one or another of the dating models. A tentative procedure for evaluating data is given. For linear profiles, all models give the same chronology. For non-linear profiles, if the Pb-210 residuals are comparable with the known atmospheric flux, or with the Pb-210 residuals or nearby cores, the constant rate supply model would appear to be applicable. If the Pb-210 residuals do not satisfy the requirements of the constant rate supply model, but there is independent evidence that the primary sediment accumulation rate has been constant, the constant initial concentration model will be applicable. This case may occur in situations where sediment focusing takes place. If the Pb-210 residuals do not satisfy the requirements of either model, a Pb-210 chronology cannot be reliably established. Pb-210 dates calculated in these circumstances frequently have been in conflict with independent dating evidence. (Baker-IVI)
W84-05208

MINERAL MAGNETIC STUDIES OF LAKE SEDIMENTS,
Liverpool Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2H.
W84-05209

CHANGING PATTERNS OF SEDIMENT ACCUMULATION IN A SMALL LAKE IN SCANIA, SOUTHERN SWEDEN,
Coventry (Lanchester) Polytechnic (England). Dept. of Geography.
For primary bibliographic entry see Field 2H.
W84-05210

USE OF X-RAY RADIOGRAPHIC METHODS IN STUDYING SEDIMENTARY PROPERTIES AND RATES OF SEDIMENT ACCUMULATION,
Uppsala Univ. (Sweden). Naturgeografiska Inst.
V. Axelsson.
Hydrobiologia, Vol. 103, p 65-69, July, 1983. 3 Fig, 6 Ref.

Descriptors: *X-rays, *Sedimentary structures, *Sedimentation, Laminations, Sediment distribution, Lake sediments, Bays, Sweden.

X-ray radiographs of unextruded sediment cores are used for the documentation and the interpretation of primary and secondary sedimentary structures, and for the correlation of synchronous laminations between different cores. The vertical variation in bulk density, water content and void ratio, and the increase of solids with increasing sediment depth are calculated from the recorded film density along the radiographs. The X-ray radiographic technique for the study of sedimentary properties is fast and non-destructive. The technique is especially valuable when studying the uppermost part of the sediment cover and the process of sediment redistribution and sediment accumulation. Studies are being undertaken in several Swedish lakes and coastal bays, where mono- and stereoradiographs are being used to classify bottom and sediment types, to interpret changes in the depositional environment, and to calculate past and present rates of sediment accumulation. (Author's abstract)
W84-05211

TRACE ELEMENT ASSOCIATIONS AS INDICATORS OF SEDIMENT ACCUMULATION IN LAKES,
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
For primary bibliographic entry see Field 2H.
W84-05212

DIATOM AND CHRYSOPHYTE RELICT ASSEMBLAGES IN THE SEDIMENTS OF BLELHAM TARN IN THE ENGLISH LAKE DISTRICT,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2H.
W84-05217

MATHEMATICAL MODEL FOR SEDIMENT TRANSPORT OVER BEDFORMS (MATHEMATISCHES MODELL FUR DEN FESTSTOFFTRANSPORT UBER SOHLFORMEN),
Bundesanstalt fuer Wasserbau, Hamburg (Germany, F.R.). Abt. Kuste.
W. Puls.
Wasserwirtschaft, Vol. 73, No. 5, p 143-148, May, 1983. 6 Fig, 26 Ref.

Descriptors: *Sediment transport, *Sedimentation, *Sedimentary structures, Sediment grading, Sediment-carrying capacity, Ripple marks, Sedimentary basins, Sediment erosion, Physical properties, Water currents, Turbidity currents, Rip currents, Flow characteristics.

The small-scale sediment transport over transverse bedforms (ripples, dunes) is calculated by a numerical model. This calculation is based on the turbulent flow which is also computed numerically. The model effectively determines sediment transport mechanisms over ripples, dunes and level bed-

forms. The model is mainly used for the investigation of the physics of bedform mechanics. (Murphy-IVI)
W84-05241

BEGINNING OF EROSION AT SUBMERGED FLEXIBLE ROUGHNESS ELEMENTS (UBER DEN EROSIONSBEGINN BEI DER UBERSTROMUNG VON FLEXIBLEN RAUHEITSELEMENTEN),
Emschergenossenschaft, Essen (Germany, F.R.).
B. Haber.
Wasserwirtschaft, Vol. 73, No. 7/8, p 231-239, 1983. 7 Fig, 1 Ref.

Descriptors: *Soil erosion, *Overland flow, Roughness, Mathematical equations, Filter crops, Sediment deposition.

A method for the determination of erosion onset applicable for flow over artificial flexible roughness elements and natural crops was elaborated. Surface runoff erosion protection uses grasses to cover the runoff area, and sediments are left behind in heavily grassed areas. The velocity and roughness coefficients are major factors in erosion. Erosion equations were developed using gravitational complements: turbulence, force, velocity and roughness. (Moore-IVI)
W84-05248

PARTICULATE MATTER IN NATURAL WATERS (KOLLIDALE WASSERINHALTSSTOFFE IN NATURLICHEN GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
H. H. Hahn.
Wasserwirtschaft, Vol. 73, No. 11, p 434-441, 1983. 15 Fig, 33 Ref.

Descriptors: *Particulate matter, *Natural waters, *Sediment transport, Suspended solids, Dissolved solids, Metal oxides, Clays, Biocolloids.

Particulate matter represents a large fraction of all substances transported in a natural water. It is also responsible for the transport of many dissolved substances. For this reason a concept for the description of the transport of suspended solids has been developed. In laboratory investigations the aggregation of metal oxides, clays and biocolloids has been studied. With this data a computational routine was developed to describe the distribution in time and space of particulate matter in free flowing and partly impounded rivers. In-situ observations confirm the adequateness of the developed methodology. (Author's abstract)
W84-05260

INFLUENCE OF SECONDARY FLOW UPON BED FORMATION AND SEDIMENT TRANSPORT IN OPEN CHANNELS, (EINFLUSS DER SEKUNDARSTROMUNG AUF SOHLAUSBILDUNG UND SEDIMENTTRANSPORTVORGANGE IN OFFENEN GERINNEN),
C. Zimmermann.
Wasserwirtschaft, Vol 73, No. 11, p 447-452, November, 1983. 7 Fig, 15 Ref.

Descriptors: *Sediment transport, *Open channels, *Secondary flow, Alluvial channels, Model studies, Channel morphology, Scour, Channel curvature.

From investigations of the parameters determining bed formation and sediment transport in alluvial channel bends which were performed in circular laboratory flumes, analytical models could be developed for predictions of the cross sections of channel bends and sediment motion. These models have been further developed and are now the basis for technical measures to predict endangered natural channel bends. A report is also given on formation and dynamics of significant large scour holes in channel bends. It has been observed that sediment transport rates increase significantly with decreasing channel curvature, compared with results from a straight flume with the same flow conditions. (Author's abstract)
W84-05262

JET EROSION (STRAHLEROSION),
Stuttgart Univ. (Germany, F.R.).
B. Westrich, and H. Kobus.
Wasserwirtschaft, Vol. 73, No. 11, p 453-458, November, 1983. 27 Fig, 7 Ref.

Descriptors: *Jet erosion, *Erosion, Scour, Sediment erosion, Hydrodynamics, Flow velocity, Erosion rate.

Submerged jets impinging on a movable sediment bed have a strong scouring capacity. The scouring effect depends on the hydrodynamic wall pressure at the impinging region and the permeability of the bed material. Two characteristic scour forms with different erosion and transport pattern can be observed. Periodical jet velocity fluctuations improve the flow conditions at the bottom and enhance the scouring rate. (Author's abstract)
W84-05263

INVESTIGATION OF SUSPENDED SEDIMENT RATING CURVES IN WESTERN AND NORTHERN GREECE,
Athens Univ. (Greece). Dept. of Civil Engineering.
M. Mimikou.
Hydrological Sciences Journal, Vol. 27, No. 3, p 369-383, September, 1982. 9 Fig, 7 Tab, 11 Ref.

Descriptors: *Suspended sediments, *Flow discharge, *Greece, Sediment load, Seasonal variation, Sediment yield, Erosivity, Soil erosion, Rainfall distribution.

The suspended sediment rating curves for six stations on four rivers in western and northern Greece are investigated. For each station the suspended sediment load is a power function of the water discharge, which may be distinguished according to wet and dry seasons; the latter yields higher sediment loads for a given discharge than the former. This is due to the higher erosivity of dry season rainfall compared to wet season rainfall producing the same runoff. All rating curve exponents b lie in the range 2.5-3.5 for the wet and 2.0-3.0 for the dry season and are related to the constants a of the curves by empirical equations. The variation in a and b is explained in terms of the annual precipitation and area of the basin, the hypsometric fall, the main channel length, and the average bedslope of the river from the basin divide to the station, through empirical relationships, which also permit the prediction of rating curves for ungauged basins. (Author's abstract)
W84-05293

EFFECT OF RAINDROP IMPACT AND SLOPE LENGTH ON SEDIMENT CONCENTRATION OF RUNOFF,
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
J. V. Mannering, and W. C. Moldenhauer.
Proceedings of the Indiana Academy of Sciences, Vol. 92, p. 463-467, 1982. 2 Tab, 8 Ref.

Descriptors: *Rainfall-runoff relationships, *Erosion, *Sediment transport, Rainfall intensity, Rainfall impact, Simulated rainfall, Black Creek Watershed, Indiana, Erosion control.

The effect of raindrop impact and surface runoff in detaching and transporting soil material was determined. This is important in order to develop land treatment measures that will effectively reduce sediment yields from agricultural watersheds. The study was made at the EPA-supported Black Creek Watershed Sediment Study located in Allen County, Indiana. The results of simulated rainfall and inflow studies on four soils (Haskins loam, Nappanee clay loam, Hoytville silty clay, and Morley clay loam) show rainfall energy to be the major factor affecting sediment concentration of runoff from agricultural soils in a seedbed condition. Sediment concentration of rainfall-induced runoff ranged from 7 to 12 times that of inflow-induced runoff for all the soils. In the study, doubling or tripling the selected inflow to simulate increased slope length had little influence on sediment concentration. However, slope steepness did influence sediment concentration. On the test site having a 5.1% slope, sediment concentrations approximately three times those from the other three nearly level test sites occurred whether runoff was rainfall-induced, inflow induced, or a combination of both. These results demonstrate again the necessity of protecting the soil surface from raindrop impact in order to effectively reduce sediment concentrations of runoff which will, in turn, maintain soil productivity and enhance water quality. (Baker-IVI)
W84-05311

MOLECULAR DYNAMICS AND STATISTICAL MECHANICS OF WATER NEAR AN UNCHARGED SILICATE SURFACE,
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W84-05334

LOCAL SCOUR AROUND SPUR-DIKES,
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering.
N. A. Zaghloul.
Journal of Hydrology, Vol. 60, No. 1-4, p 123-140, January, 1983. 13 Fig, 20 Ref.

Descriptors: *Scour, *Spur dikes, Dikes, Spurs, Flow, Sediment, Mathematical equations, Design criteria, Froude Number.

Experimental investigations were conducted to study the effects of upstream flow conditions, sediment characteristics, and spur-dike's geometry on the maximum scour depth and scour pattern around a spur-dike. Dimensional analyses to find different nondimensional terms affecting the phenomenon were obtained and verified with the help of the experimental data. The maximum depth of scour is significantly affected by the channel's Froude number and the opening ratio at the spur-dike's location. The derived empirical formula, for the maximum depth of scour, is identical in form to the regime equations of Lacey and Blench. The formula gave a good correlation coefficient which may be used to predict the maximum scour depth for conditions similar to those covered in this study. The depth of scour progresses linearly with the logarithm of time during the development of the hole. The greater the ratio of the disturbing force to the resisting force, the greater the rate of scour. The experiments indicate that the limiting extent of scour is reached when the velocity has been reduced to its critical value due to the enlargement of the scoured section. The continuous removal of the material deposited downstream of the scour hole provides proper simulation of prototype conditions and has the advantage of considerably saving experimental run time. The clear water condition, under which the experiments were conducted, yields deeper and larger scour holes, which confirms the fact that this condition is more critical regarding design criteria. (Baker-IVI)
W84-05352

MODELLING SEDIMENT TRANSPORT AS A MOVING WAVE - THE TRANSFER AND DEPOSITION OF MINING WASTE,
Australian National Univ., Canberra. North Australia Research Unit.
G. Pickup, R. J. Higgins, and I. Grant.
Journal of Hydrology, Vol. 60, No. 1-4, p 281-301, January, 1983. 5 Fig, 1 Tab, 17 Ref.

Descriptors: *Mine wastes, *Sediment transport, Model studies, Waves, Velocity, Papua, New Guinea, Kawerong River, Bougainville Island.

The movement of slugs of bedload from a discrete input point down a river has proved difficult to model using conventional finite-difference formulations of equations of motion. A model is proposed which makes explicit allowance for the mean sediment velocity and, through a dispersion coefficient, the distribution of sediment velocity about the mean. A second comparative model uses the normal mass conservation or sediment transport continuity approach. The models have been tested over a 43 month period using data from seven monitored cross-sections of the Kawerong River on Bougainville Island, Papua New Guinea, a

system which receives waste from a large copper mine. The dispersion model performs considerably better than the mass conservation model. While the overall volume of sediment transported is of the correct order of magnitude, the model is not accurate enough to predict the basic pattern of deposition through time. It also fails to reproduce the pattern of downstream variations in deposition and on many sections shows rapid fluctuations which did not occur. The dispersion model seems to damp out these fluctuations and produces a more realistic sequence of river behavior. In an operational context, the information usually required is the height of deposition rather than its area. Even at its worst, the dispersion model gives few heights with errors of more than 3 m and for most of the time, the errors are less than 1 m which is adequate for most practical applications. (Baker-IVI)
W84-05362

2K. Chemical Processes

INFLUENCE OF NATURAL ORGANIC MATTER ON THE ADSORPTION PROPERTIES OF MINERAL PARTICLES IN LAKE WATER,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 2H.
W84-04904

EQUILIBRIUM APPROACHES TO NATURAL WATER SYSTEMS - PART 2; IN SITU DETERMINATION OF THE EQUILIBRIA H2CO3 EQUILIBRIUM HCO3(-) + H(+) IN THE TEMPERATURE RANGE 4-18 DEGREES C IN A LAKE WATER OF 1.6 MM IONIC STRENGTH,
Umea Univ. (Sweden). Dept. of Inorganic Chemistry.
For primary bibliographic entry see Field 2H.
W84-04918

INFLUENCE OF METAL COMPOUNDS ON FULVIC ACID/MOLYBDENIUM BLUE REACTIVE PHOSPHATE ASSOCIATIONS,
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W84-05004

PHOTOCHEMICAL GENERATION OF HYDROGEN PEROXIDE IN NATURAL WATERS,
California Univ., Davis. Dept. of Environmental Toxicology.
W. M. Draper, and D. G. Crosby.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 121-126, January, 1983. 4 Fig, 5 Tab, 25 Ref.

Descriptors: *Hydrogen peroxide, *Photochemical reactions, *Natural waters, Tryptophan, Solar radiation, Photodecomposition, Oxidants, Eutrophication, Tyrosine, Phenols, Analines.

The photochemical formation of hydrogen peroxide in tryptophan solutions and natural waters was monitored by a sensitive spectrophotometric assay. Peroxide was characterized by ion exchange properties and mobility via thin-layer chromatography. Tryptophan photodecomposed in sunlight or near ultraviolet light (gamma $>$ 283 nm) with the formation of uncharacterized, acidic photoproducts and hydrogen peroxide: other oxidants (i.e. organic peroxides) were not detected in tryptophan photolysis mixtures. After brief exposure to sunlight, hydrogen peroxide in natural waters varied from below the detection limit (1.5 micro M) to 6.8 micro M; in highly eutrophic samples peroxide was formed in excess of 30 micro M. A humic acid soil extract, tyrosine, and several aromatic compounds including substituted phenols and anilines also generated stable photochemical oxidants suggesting that many compounds may serve as sources for hydrogen peroxide in natural waters. (Author's abstract)
W84-05175

EXCHANGE PROCESSES AT THE SURFACE OF WATER (AUSTAUSCHVORGANGE AN DER OBERFLACHE VON GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydrologie und Wasserwirtschaft.
E. J. Plate, and R. Friedrich.
Wasserwirtschaft, Vol. 73, No. 11, p 427-433, November, 1983. 10 Fig, 21 Ref.

Descriptors: *Surface water, *Air-water interfaces, *Chemical properties, *Physical properties, Turbulent flow, Turbidity flow, Turbidity currents, Turbidity, Surface tension, Heat balance, Wave propagation, Wind-driven currents.

The physical and chemical characteristics of water and air are significantly changed by wind induced exchange processes. The interaction of wind and water generates waves and turbulence in the boundary layers on both sides of the water surface. The turbulence influences the transport of heat, vapor, and gases through the interface between water and air. Laboratory investigations concerning such problems led to some basic results, particularly with regard to wind on flowing water. (Author's abstract)
W84-05259

STUDY OF THE CYCLING OF MANGANESE AND OTHER ELEMENTS IN A SEASONALLY ANOXIC LAKE, ROSTHERNE MERE, U.K.,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2H.
W84-05319

SOIL-WATER RESIDENCE TIME AND SOLUTE UPTAKE. 1. DYE TRACING AND RAINFALL EVENTS,
Sheffield Univ. (England). Dept. of Geography.
S. T. Trudgill, A. M. Pickles, K. R. J. Smettem, and R .W. Crabtree.
Journal of Hydrology, Vol. 60, No. 1-4, p 257-279, January, 1983. 11 Fig, 3 Tab, 54 Ref.

Descriptors: *Rainfall, *Infiltration, Soil water, Tracers, Solubility.

Fluorescent dyes have been used to label rainfall infiltrating into a well-structured calcareous woodland soil in situ. Soil-water outflow was monitored using throughflow troughs. The occurrence of dye output from the soil could not be totally predicted by the use of a simple storage model but was related to the occurrence of intense-rainfall events equal to or greater than 3 mm/hr lasting for at least 2 hr. Precise specification of intensity conditions is not simple because of canopy interception and in storm variations in intensity. Sustained intense rainfall leads to output and additional work should be able to more accurately quantify the threshold conditions. In terms of actual physical conditions, details of canopy interception, soil dye pathways, soil-moisture variations and incremental movement through the soil during successive storms prior to final output are important factors for further study. Dye studies may be used in the field to identify mobile soil water at an output point, using short trace distances, but not for quantitative recovery analysis. (Baker-IVI)
W84-05361

2L. Estuaries

UNSTEADY TRANSPORT OF SUSPENDED LOAD AT SMALL CONCENTRATIONS,
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
For primary bibliographic entry see Field 2J.
W84-04825

REGIONAL STEADY INTERFACE BETWEEN FRESH WATER AND SALT WATER IN A COASTAL AQUIFER,
Ehime Univ., Matsuyama (Japan). Dept. of Applied Physics.
Y. Kishi, Y. Fukuo, T. Kakinuma, and M. Ifuku.
Journal of Hydrology, Vol. 58, No. 1-2, p 63-81, August, 1982. 11 Fig, 18 Ref.

Descriptors: *Saline water intrusion, *Saline-freshwater interfaces, *Coastal aquifer, Model studies, Hydrologic models, Hydraulic conductivity, Naka River estuary, Tokushima Prefecture, Japan.

The phenomenon of seawater intrusion into groundwater has often been observed in coastal regions. The shape and position or the movement of the interface may be closely related to the inflow or height of groundwater at the upstream boundary, the amount of groundwater pumped and the amount of the infiltration by precipitation. A theoretical model is presented which is useful for determining the regional steady interface between fresh water and salt water under the appropriate boundary conditions for both confined and unconfined aquifers. This model is then applied to the confined groundwater in the estuary of the Naka River, Tokushima Prefecture, Japan, and the phenomenon of the seawater intrusion into the aquifer is analyzed. Boundary conditions of the confined aquifer and the parameters necessary for analysis are determined from the data. Calculations using a finite-element method are carried out in various cases, by changing the inflow SR or the total pumping amount Q of the groundwater in this alluvial plain. It is found that the region where salt water is intruding expands rapidly inland when SR approached Q and vice versa. It is also found that the distributions of chloride ion concentration in groundwater calculated by this model with a simplified assumption are in fairly good agreement with the results observed in deep wells. (Murphy-IVI)
W84-04839

EFFECT OF NON-DARCY FLOW ON COMPUTING SEAWATER INTRUSION LENGTHS,
Centre for Water Resources Development and Management, Calicut (India).
P. Basak, and S. P. Rajagopalan.
Journal of Hydrology, Vol. 58, No. 1-2, p 83-87, August, 1982. 3 Fig, 1 Tab, 2 Ref.

Descriptors: *Groundwater movement, *Saline water intrusion, Coastal aquifers, Darcy's Law, Saline water, Water quality control, Aquifers.

An analytical solution for the seawater intrusion length in coastal aquifers under steady state under non-Darcy flow is presented. The length of seawater intrusion increased as the flow deviated more and more from Darcian linearity. This implies that there will be an underestimation of the seawater intrusion length if the Darcian condition of flow is assumed while in the actual case this may not hold true. It is believed that the analysis presented and the results reported would be of use in correctly computing the seawater intrusion length in coastal aquifers where non-Darcy flow is likely to occur. (Baker-IVI)
W84-04840

LONGEVITY OF ALGAL INHIBITION AFTER CHLORINATION OF ESTUARINE WATER,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
J. G. Sanders.
Environmental Science and Technology, Vol. 18, No. 5, p 383-385, 1984. 1 Fig, 1 Tab, 21 Ref.

Descriptors: *Estuaries, *Chlorination, *Inhibition, *Algae, Water pollution effects, Chlorine, Bioaccumulation, Copper, Biocontrol, Chemical properties.

Estuarine water was chlorinated to 10 mg/L, aged 10-35 days, and then used as a growth medium for three phytoplankton species. Total residual chlorine compounds were undetectable in the chlorinated water; however, two species would not grow even after the water had been aged 35 days. A more resistant species grew in chlorinated water aged 23 or 35 days but would not grow in water aged 10 days. All three species grew well in the same water that had not been chlorinated. The degree of chlorination as well as the aging time was important in determining cell growth. In addition, algal resistance to trace metal (Cu) toxicity was reduced, possibly due to increased activity of

the free Cu ion. The quantity of organic carbon oxidized during the degradation of chlorine residuals is sufficient to destroy the Cu binding capacity of estuarine waters. (Author's abstract)
W84-04891

COMPARATIVE ECOLOGY OF NEKTON RESIDING IN A TIDAL CREEK AND ADJACENT SEAGRASS MEADOW: COMMUNITY COMPOSITION AND STRUCTURE,
Virginia Commonwealth Univ., Richmond. Dept. of Biology.
M. P. Weinstein, and H. A. Brooks.
Marine Ecology - Progress Series, Vol. 12, No. 1, p 15-27, April, 1978. 7 Fig, 4 Tab, 44 Ref. EPA grant R 808707.

Descriptors: *Comparison studies, *Nekton ecology, *Estuaries, *Species composition, Vaucluse Shores, Virginia.

A structural analysis of the nekton communities occupying a tidal creek and adjacent seagrass meadow at Vaucluse Shores, Virginia (Delmarva Peninsula, USA) is presented along with a comparison of the relative value of each habit to the early life stages of marine and estuarine species. Seagrass meadows were characterized by significantly greater richness and diversity of constituent taxa; both areas, nevertheless, contained mixtures of habitat specialists and wide-ranging (ubiquitous) species that displayed no areal preferences. Except for a few resident forms, much of the nekton community in the grassbed was comprised of less abundant 'southern' species that entered the Chesapeake Bay in late summer and fall. Reciprocal averaging and numerical classification procedures applied to pooled station collections further indicated the clinical nature of species distributions among habitats, but also clearly demonstrated several microhabitat associations for either the Zostera marina or Ruppia maritima portions of the grassbed. The sciaenid, Leiosotomus xanthurus dominated the nekton in both habitats, with > 80% of all individuals but were nearly 4 times as abundant in the tidal creek. Abundance distribution and length frequency analyses for this species indicated that the marsh is the preferred habitat but also that larger individuals in the population continuously 'bled off' into downstream areas. Two other species of regional importance, Callinectes sapidus and paralichthys dentatus, also utilized both habitats extensively. Late in summer and early fall, juveniles of both species were more abundant in the grassbed, whereas earlier in the year, they were randomly dispersed. The apparently limited dependence on both the grassbed and tidal creek by the young of local taxa is strikingly different when compared to similar habitats at lower latitudes. In light of the differences established between these habitats and their utilization by different species, an attempt is made to identify potentially important determinants of community structure and relate these to the success of individual populations in both areas. (Murphy-IVI)
W84-04897

INFLUENCE OF RIVER-OCEAN PLUMES UPON BACTERIOPLANKTON PRODUCTION OF THE STRAIT OF GEORGIA, BRITISH COLUMBIA,
Simon Fraser Univ., Burnaby (British Columbia). Dept. of Biological Sciences.
L. J. Albright.
Marine Ecology - Progress Series, Vol. 12, No. 2, p 107-113, May, 1983. 6 Fig, 22 Ref.

Descriptors: *River-ocean plumes, *Ecological effects, *Bacterioplankton, *Strait of Georgia, *British Columbia, Aquatic productivity, Salinity, Estuaries, Fraser River, Squamish River, Homathko River, Southgate River, Plumes, Microenvironment.

The Strait of Georgia which has a calculated volume of ca. 1025 cu km of estuarine water, annually receives about 145 cu km of runoff water, mainly from rivers, creeks and streams. Stimulation in bacterioplankton glucose heterotrophic activities and productivities occurs when river water (Fraser, Squamish and Homathko-Southgate rivers) enter the saline surface waters of the Strait of Georgia, British Columbia, Canada. As the lower salinity water of the Fraser plume (ca. half of the fresh water flow into this Strait comes from this river) mixes into adjacent surface waters of the Strait, bacterioplankton production remains significant till the salinity exceeds ca. 20% S. Since lower salinity water (i.e. < or = ca. 20% S) from river plumes covers extensive areas of the Strait of Georgia during the annual freshet (ca. April to July) there is a significant annual bacterial contribution to total microbial production within this estuarine ecosystem. (Murphy-IVI)
W84-04898

PREFERENTIAL INGESTION OF ORGANIC MATERIAL BY THE AMERICAN OYSTER CRASSOSTREA VIRGINICA,
Maryland Univ., Cambridge. Horn Point Environmental Labs.
R. I. E. Newell, and S. J. Jordan.
Marine Ecology - Progress Series, Vol. 13, No. 1, p 47-53, July, 1983. 4 Fig, 36 Ref. NOAA grant RF 14.

Descriptors: *Preferential ingestion, *Organic matter, *American oyster, Biofiltration, Biofilters, Food habits, Diets.

Using an artificial diet, composed of silt < 32 micro m in diameter and the algal Tetraselmis suecica, it was demonstrated that the oyster Crassostrea virginica could significantly reduce the concentration of algae voided in the pseudofeces (measured as extracted chlorophyll pigment) by over 50%, compared to levels in the food. More importantly, it was also shown that for C. virginica fed natural seston at concentrations between 4 to 20 mg/l, the proportion of energy, carbon and nitrogen voided in the pseudofeces could also be reduced significantly compared to that in the food. As the organic material in natural seston is from a wide range of sources - e.g. phytoplankton of different sizes, bacteria, detritus particles, etc. - these results indicate that C. virginica has a well developed ability to ingest preferentially various types of organic material and to reject other particles as pseudofeces. This discriminatory mechanism must be able to operate on individual particles despite the fact that they are bound in viscous mucus. We hypothesize (based on literature information for the properties of molluskan mucus) that the viscosity of the mucus in which the food particles are entrapped may be significantly reduced by the ciliary action on the ridged surfaces of the opposed labial palps. This reduced viscosity mucus is possibly moved to the free edge of the palp where, with a cessation of the mechanical stimulation, it regains its original viscosity. The individual particles may then be subject to chemical testing by chemoreceptors which determine whether a particle is moved over the palp ridge to the mouth or is admitted to the deep rejection tracts. These rejected particles move to the free edge of the palps where they are re-incorporated in the mucus and rejected as pseudofeces. (Author's abstract)
W84-04900

TIDAL CORRECTIONS IN HYDROGRAPHIC SURVEYING,
Old Dominion Univ., Norfolk, VA. Dept. of Oceanography.
C. Blair.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 109, No. 1, p 31-40, February, 1983. 5 Fig, 7 Ref.

Descriptors: *Hydrographs, *Tidal effects, Errors, Surveys, Water depth, Hydrography, Estuaries.

Depth errors may occur in hydrographic surveys if tidal corrections are determined from water surface heights measured at points distant from the immediate vicinity of the soundings. Use of predicted rather than measured heights is another potential cause of error. Errors are presented for a hypothetical calculation of dredging pay quantities. Procedures for reducing errors are suggested, and methods of measuring tide height described. The tidal correction to hydrographic soundings is a function both of time and of location. For greatest accuracy the surveyor must determine the geodetic elevation of the water surface in the immediate vicinity of each sounding. In selecting locations of tide gages for a survey, engineering judgement and knowledge of estuarine and oceanographic principles are required in balancing accuracy requirements against cost. Only as a last resort should corrections be based upon predicted astronomical tide heights; actual measurement is needed to detect variations caused by meteorological conditions. Tide gages work on a variety of physical principles and span a wide range of complexity, flexibility, accuracy, and cost. The choice of gage type depends on the requirements of the particular survey under consideration. (Baker-IVI)
W84-04961

TWO-DIMENSIONAL BRANCHING SALT INTRUSION MODEL,
Argonne National Lab., IL. Energy and Environmental Systems Div.
D.-P. Wang.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 109, No. 1, p 103-112, February, 1983. 7 Fig, 7 Ref, 3 Append. Maryland Dept. of Natural Resources contracts P40-78-04, P62-80-04.

Descriptors: *Saline water intrusion, *Model studies, *Chesapeake Bay, *Susquehanna River, *York River, Bays, Rivers, Salinity, Low flow, Simulation, Mixing, Gravitational circulation.

A two-dimensional branching model is developed to simulate salinity distribution in complex estuaries. The model is applied to a one-month salinity study in the Chesapeake Bay during a period of low freshwater discharges from the Susquehanna River. The high salinity water is advected upstream in the lower layer by the density-driven (gravitational) circulation. The lower layer water is mixed upward, resulting in a salinity increase through the water column. The total salinity increase and the extent of salt intrusion depends on the parameterization of vertical mixing and friction. For instance, stronger mixing across the halocline will significantly increase the total salinity. The effect of the longitudinal mixing can be completely neglected. Sensitivity analysis with a flow reduction in the Susquehanna River suggests significant increase of total salinity in the upper bay. The flow reduction will also enhance bottom water intrusion over the entire bay. This latter effect is caused by the internal pressure (density) adjustment. A dramatic example of the rapid bottom water intrusion was found in the York River during the relaxation of a high-flow episode. The use of a two-dimensional model correctly simulates the key features in salt intrusion. The long-term simulation will also eliminate the aliasing of verification data caused by short-period atmospheric forcing and tidal effects. (Baker-IVI)
W84-04963

DEGRADATION OF AMINO ACIDS AT A SIMULATED WATER-SEDIMENT INTERFACE OF A MEDITERRANEAN LAGOON ENVIRONMENT, GOLFE DU LION (DEGRADATION D'ACIDES AMINES A L'INTERFACE EAU-SEDIMENT RECONSTITUE D'UNE LAGUNE MEDITERRANEENNE (GOLFE DU LION)),
Endoume Marine Station and Oceanography Centre, Marseille (France).
R. Daumas, F. Gadel, G. Cahet, and A. Dinet.
Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 2, p 201-213, 1984. 4 Fig, 2 Tab, 20 Ref.

Descriptors: *Water-sediment interfaces, *Lagoons, *Amino acids, *Chemical reactions, Arginine, Lysine, Degradation, Mediterranean Sea, Mineralization, Radioactive tracers.

The respiratory activity measurement and the study of incorporation processes of the radioactivity in specific organic fractions of the C-14 labeled arginine were among the four day experiments at a simulated water-sediment interface of a mediterranean lagoon environment. During the first day active mineralization occurred, after which the

radioactivity in the acid-soluble fraction decreased and polycondensed products were progressively incorporated. The radioactivity of the H-3 labeled lysine was included mainly in the acid soluble fraction. The radioactivity distribution in the organic fractions was affected by the nature of the substrate, and the reducing conditions in the environment. The identification of amino acids in the acid-soluble and base soluble fractions shows that the labelled arginine and lysine released from the initial compounds are important quantitatively. (Baker-IVI)
W84-05014

GAS EXCHANGE RATES ACROSS THE SEDIMENT-WATER AND AIR-WATER INTERFACES IN SOUTH SAN FRANCISCO BAY,
University of Southern California, Los Angeles. Dept. of Geological Sciences.
B. Hartman, and D. E. Hammond.
Journal of Geophysical Research, Vol. 89, No. C3, p 3593-3603, May, 1984. 7 Fig, 5 Tab, 40 Ref. NSF grants OCE 7909412 and OCE 8209249, OSG grant NA81AA-D00094.

Descriptors: *Gas exchange, *San Francisco Bay, *California, *Water-sediment interfaces, *Air-water interfaces, Radon radioisotopes, Channels, Shoals, Wind.

Radon 222 concentrations in the water and sedimentary columns and radon exchange rate across the sediment-water and air-water interfaces have been measured in a section of south San Francisco Bay. Two independent methods have been used to determine sediment-water exchange rates, and the annual averages of these methods agree within the uncertainty of the determinations, about 20%. The annual average of benthic fluxes from shoal areas is nearly a factor 2 greater than fluxes from the channel areas. Fluxes from the shoal and channel areas exceed those expected from simple molecular diffusion by factors of 4 and 2, respectively, apparently due to macrofaunal irrigation. Values of the gas transfer coefficient for radon exchange across the air-water interface were determined by constructing a radon mass balance for the water column and by direct measurement using floating chambers. The chamber method appears to yield results which are too high. Transfer coefficients computed using the mass balance method range from 0.4 m/day to 1.8 m/day, with a 6-year average of 1.0 m/day. Gas exchange is linearly dependent upon wind speed over a wind speed range of 3.2-6.4 m/s, but shows no dependence upon current velocity. Gas transfer coefficients predicted from an empirical relationship between gas exchange rates and wind speed observed in lakes and the oceans are within 30% of the coefficients determined from the radon mass balance and are considerably more accurate than coefficients predicted from theoretical gas exchange models. (Author's abstract)
W84-05111

GROUPS OF WAVES IN SHALLOW WATER,
Scripps Institution of Oceanography, La Jolla, CA.
S. Elgar, R. T. Guza, and R. J. Seymour.
Journal of Geophysical Research, Vol. 89, No. C3, p 3623-3634, May, 1984. 10 Fig, 1 Tab, 28 Ref. OSG contracts NOAA-04-8-M01-193 and R-CZ-N-4E, ONR contract N00014-75-C-0300.

Descriptors: *Waves, *Mathematical models, Simulation, Wave height, Water depth.

Wave group statistics predicted by linear theories are compared to numerical simulations, thus determining ranges of spectral shapes for which the theories are valid. It is found that these theories are not generally valid for ocean data because of many assumptions and simplifications beyond linearity and random phase or because their range of applicability does not include the vast majority of ocean conditions. The simulations also provide quantitative information about the variability of linear wave group statistics which is useful when examining ocean field data. The simulation technique is used to show that important ocean gravity wave group statistics are not inconsistent with an underlying wave field composed of linearly superposed random waves. The majority of the field data examined were collected in 10 m depth: significant wave heights varied from about 20 to 200 cm, and the spectral shapes ranged from fairly narrow to broad ($1 < Qp < 6$). For the 10-m depth data, the observed mean run length, variance of run length, and probabilities of runs of a given number of waves were statistically consistent with the simulations. In contrast to the apparently linear groups observed in 10 m depth, waves in 2-3 m depth showed marked departures from the linear simulations. (Author's abstract)
W84-05112

NUTRIENT TRAPPING BY SEDIMENT DEPOSITION IN A SEASONALLY FLOODED LAKESIDE WETLAND,
Wisconsin Univ.-Madison. Dept. of Soil Science.
C. A. Johnston, G. D. Bubenzer, G. B. Lee, F. W. Madison, and J. R. McHenry.
Journal of Environmental Quality, Vol. 13, No. 2, p 283-290, April-June, 1984. 6 Fig, 3 Tab, 26 Ref. EPA grant R804823.

Descriptors: *Wetlands, *Sediment deposition, *Nutrients, Water quality, Soil chemistry, Nitrates, Phosphates, Flooding, Alluvium, White Clay Lake, Wisconsin.

Sediment and nutrient retention was studied in a seasonally flooded lakeside wetland as a natural mechanism for preventing water quality deterioration. Both wetland and upland soils in the watershed had comparable concentrations of inorganic P on a per-volume basis, while NH4(+)-N and organic forms of N and P were much higher in the wetland soils. Nitrate concentrations expressed in a per-volume basis were lower in the wetland soils than in the upland soils. The distribution of sediment and nutrients in the wetland was correlated with distance from a small stream flowing through the wetland. Deposition patterns were affected by recent stream channel migrations. The accumulation of nutrients and sediment delivered from the upland to wetland soils was estimated in two ways: (i) by calculating the volume of alluvium deposited in low natural levees adjacent to the stream; and (ii) by estimating nutrient and ash enrichment of histic surface soils farther away from the stream. Although the levees constituted only about 20% of the wetland surface area, they accounted for 81% of the sediment, 84% of the N, and 67% of the P retained by the wetland. The depth of Cs-137 in the soil was used to estimate net sedimentation rates. Average annual accumulations over the wetland as a whole were: 2.0 kg sediment/sq m/yr, 2.6 g P/sq m/yr, and 12.8 g N/sq m/yr. Since these values exceed those published for average annual storage by wetland plants, soil mechanisms are more important than vegetative uptake for long-term nutrient and sediment retention in the White Clay Lake wetland. (Author's abstract)
W84-05121

APPLICATION OF COLUMBIA HYBRID MODELING SYSTEM,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
W. H. McAnally, Jr., J. V. Letter, Jr., J. P. Stewart, W. A. Thomas, and N. J. Brogdon, Jr.
Journal of Hydraulic Engineering, Vol. 11, No. 5, p 627-642, May, 1984. 15 Fig, 4 Tab, 6 Ref.

Descriptors: *Model studies, *Estuaries, *Columbia River, Columbia Hybrid Modeling System, Runoff, Waves, Tidal effects, Shoals, Sedimentation.

The Columbia Hybrid Modeling System was applied to navigation channel shoaling problems at the mouth of the Columbia River estaury. The adjustment process created a typical year from a statistical analysis of river runoff and waves combined with a typical tide. The Columbia hybrid modeling method integrates field data, analytical techniques, a physical model, and numerical models into a solution technique that uses each method to do that which it performs best. The Columbia hybrid modeling method yielded results that are believed to be superior to any other presently available production-level technique. The Columbia River estuary physical model has been verified to satisfactorily reproduce observed prototype water surface evaluations and current velocities. Results of model predictions of changes in hydraulics from model base test results are considered reliable indications of expected prototype behavior. The Columbia entrance hybrid model has been verified to yield accurate reproductions of total dredged volume and longitudinal channel shoaling distribution, and satisfactorily accurate cross channel shoaling patterns. The model overpredicts shoaling on the outer bar. Results of model predictions can be considered reliable indications of the effects of possible modifications to the entrance in terms of changes from the base conditions, so long as those modifications do not severely alter the flow regime. The techniques developed are flexible enough and general enough to permit their application to many similar sedimentation problems in rivers and estuaries. (Baker-IVI)
W84-05149

CHANGES IN DIATOM FLORA DEPOSITED ANNUALLY DURING THE FRESHENING OF THE IMPOUNDED, SEA-BAY OF GENNARBY-VIKEN IN SOUTHERN FINLAND,
Turku Univ. (Finland). Dept. of Quaternary Geology.
M. Rasanen, and K. Tolonen.
Hydrobiologia, Vol. 103, p. 147-152, July, 1983. 5 Fig, 20 Ref.

Descriptors: *Diatoms, *Salinity, *Water resources development, *Finland, *Gennarbyviken Bay, Sulfides, Mud, Sediments, Environmental effects, Bays.

Gennarbyviken is a 17-km long sea-bay on the northern coast of the Gulf of Finland. It was dammed in 1957-58 to form a fresh-water supply. Diatoms were studied in an annually laminated sulfide mud which was deposited after the impoundment of the sea-bay of Gennarbyviken. It was possible to follow how the measured decrease in salinity in the basin was reflected by the diatom flora of the sediment which had been deposited concurrently. At the beginning of the freshening period (6-8 years), decreasing salinity was the most important factor which caused changes in the diatom communities. Diatoms reacted immediately to the decreasing salinity. Afterwards oligohalobes became the dominant species group. Results were compared with another study and it was determined that when changes are monitored through time, more precise information about the salinity ecology for diatoms can be acquired than when differences in space are studied where the sources of error are bigger. (Baker-IVI)
W84-05220

DENITRIFICATION IN SAN FRANCISCO BAY INTERTIDAL SEDIMENTS,
Geological Survey, Menlo Park, CA.
R. S. Oremland, C. Umberger, C. W. Culbertson, and R. L. Smith.
Applied and Environmental Microbiology, Vol. 47, No. 5, p 1106-1112, May, 1984. 4 Fig, 4 Tab, 32 Ref.

Descriptors: *Denitrification, *San Francisco Bay, *Intertidal sediments, Estuaries, Nitrates, Nitrogen removal, Chemical properties, Sediment slurries, Ions.

Denitrification can benefit aquatic environments faced with eutrophication. The Sediments were taken from an intertidal mudflat located in South San Francisco Bay. Acetylene block technique was employed to study denitrification in intertidal estuarine sediments. Addition of nitrate to sediment slurries stimulated denitrification. During the dry season, sediment-slurry denitrification rates displayed Michaelis-Menten kinetics, and ambient NO3(-) + NO2(-) concentrations (< or = 26 micro M) were below the apparent Km (50 micro M) for nitrate. During the rainy season, when ambient NO3(-) + NO2(-) concentrations were higher (37 to 89 micro M), an accurate estimate of the Km could not be obtained. Endogenous deni-

trification activity was confined to the upper 3 cu cm of the sediment column. However, the addition of nitrate to deeper sediments demonstrated immediate N2O production, and potential activity existed at all depths sampled (the deepest was 15 cm). Loss of N2O in the presence of C2H2 was sometimes observed during these short-term sediment incubations. Experiments with sediment slurries and washed cell suspensions of a marine pseudomonad confirmed that this N2O loss was caused by incomplete blockage of N2O reductase by C2H2 at low nitrate concentrations. Areal estimates of denitrification (in the absence of added nitrate) ranged from 0.8 to 1.2 micro mol of N2/sq m/h (for undisturbed sediments) to 17 to 280 micro mol of N2/sq m/h (for shaken sediment slurries). (Murphy-IVI)
W84-05281

DISTRIBUTION AND GEOCHEMISTRY OF SOME TRACE METALS IN THE BERMUDA COASTAL ENVIRONMENT,
Bermuda Biological Station for Research, St. George's West.
T. D. Jickells, and A. H. Knap.
Estuarine, Coastal and Shelf Science, Vol. 18, No. 3, p 245-262, March, 1984. 7 Fig, 7 Tab, 37 Ref.

Descriptors: *Geochemistry, *Trace metals, *Bermuda, *Coastal waters, Metals, Chemical analysis, Sediments, Path of pollutants.

Results of the analyses of the water column and sediments of the Bermuda Platform for Cd, Cu, Fe, Mn, Ni, Pb and Zn are presented. The major process controlling the water column concentrations is physical mixing of open ocean waters with inshore waters, which are polluted by a wide range of diffuse inputs. Sedimentation within the inshore waters plays a lesser, but significant, role as do fluxes from the sediments of Fe and Mn and possibly phytoplankton uptake of Zn. Concentrations within the sediments are controlled by the formation of trace metal enriched clay/organic particles in the inshore areas and their subsequent redistribution by sediment resuspension, except for Fe and Mn which are largely associated with clay lattices. (Author's abstract)
W84-05287

SHELL OF MYTILUS AS AN INDICATOR OF ZONAL VARIATIONS OF WATER QUALITY WITHIN AN ESTUARY,
Dundee Univ. (Scotland). Dept. of Geology.
For primary bibliographic entry see Field 5B.
W84-05288

STRATIGRAPHIC EVIDENCE OF EUTROPHICATION IN AN ESTUARY,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
G. C. Brush.
Water Resources Research, Vol. 20, No. 5, p 531-541, May, 1984. 5 Fig, 5 Tab, 41 Ref.

Descriptors: *Eutrophication, *Estuarine environment, *Stratigraphy, Algal growth, Chlorophyll, Sediments, Watershed, Fertilizers, Black River, Chesapeake Bay, Bays.

Using vertical profiles of sedimentary chlorophyll degradation products extracted from sediment cores, a comparison was made of algal productivity in Black River, an estuary of Chesapeake Bay, during the time prior to urbanization when the watershed was cultivated extensively for agriculture with productivity during the period of urbanization when secondarily treated effluent was discharged into the river from a sewage treatment plant. The productivity of the Black River was then compared to that of an adjacent estuary, Middle River, during the same time period. Vertical changes in chlorophyll degradation products showed a significant increase in algal productivity with the introduction of sewage effluent into the river. By comparison, algal production during intensive agriculture of the watershed, including heavy applications of fertilizers, was less by an order of magnitude where there was no sewage discharge from a point source. Concentrations of orthophosphorus correspond with concentrations of algal cells and chlorophyll in the water column and are greater by an order of magnitude where sewage is discharged into an estuary draining an urban-agricultural watershed than where there is no sewage. The response of the estuary to short- and long-term changes in the amount of sewage discharged is reflected by similar changes in chlorophyll production. However, chlorophyll production does not correspond with increases in the amount of fertilizers used in recent years over the amount used in the middle to late nineteenth century. (Baker-IVI)
W84-05327

SURFACE INFILTRATION IN SALT MARSHES: THEORY, MEASUREMENT, AND BIOGEOCHEMICAL IMPLICATIONS,
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab. for Water Resources and Hydrodynamics.
For primary bibliographic entry see Field 2G.
W84-05332

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

REVERSE OSMOSIS MEMBRANES BASED ON CYCLOALIPHATIC IMIDE POLYMERS,
Rohm and Haas Co., Springhouse, PA. Research Div. Labs.
P. G. Cartier, and P. Osei-Gyimah.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84 171107, Price codes: A04 in paper copy, A01 in microfiche. Completion Report, (1984). 64 p, 8 Fig, 24 Tab, 10 Ref, 1 Append. Project No. OWRT C-00148-S(9406)(1), Contract/Grant No. 14-34-0001-9406.

Descriptors: *Reverse osmosis, *Membrane processes, *Desalination, Polymers, *Polymer synthesis, *Cycloaliphatic imide polymers, Direct osmosis, Dense membranes.

Cycloaliphatic polyglutarimides are promising new membrane polymers. Water and salt permeabilities of the new imide polymers as measured by direct osmosis and the chemical stability of these membranes show that several of the novel imides are intrinsically suited for fabrication into reverse osmosis membranes. Water/salt permeability ratios determined by direct osmosis range from 400 to 2400. Similar ratios are reported for dense membranes prepared from cellulose acetate. Membrane performance is not degraded by a 124 hour soak in 250 ppm Cl2 at pH = 10.5. However, we have been unsuccessful in attempts to fabricate these polymers into membranes with NaCl rejection greater than 90%. Dense, asymmetric and thin film composite membranes were prepared. Nine new polymers were synthesized from the polymeric ammonia imide (R=H) by the substitution of a series of R-groups for the H of the ammonia imide. The R-groups were chosen to promote moisture uptake in the resulting polymer. The ammonia imide base polymer was selected for its good thermal and mechanical properties and its chemical stability. Dense membranes of the ammonia imide(R=H) increased salt rejection. However, NMR analysis shows that the increase in rejection is due to glutarimide ring opening. Ring opening is undesirable as it lowers the mechanical and chemical stability of the polymer.
W84-04883

TECHNOLOGICAL AND ENVIRONMENTAL ASPECTS OF DESALINATION,
Silver (R.S.), Oakbank (Scotland).
R. S. Silver.
Desalination, Vol. 42, No. 1, p 1-9, July, 1982.

Descriptors: *Desalination, *Reviews, Technology, Environmental effects, History, Thermodynamics.

Industrial and sociological importance of desalination are reviewed. The history of its development, particularly in the last two decades is described and the task of foreseeing the developments to come in the next twenty years is attempted. Fundamental analysis of desalination processes is offered in terms of thermodynamics, demonstrating the interaction between practical necessities and thermodynamic imperatives. It is shown how the implications of the analysis have in fact been confirmed by the history of development, and so suggests confidence in the interpretation for the future. (Baker-IVI)
W84-04926

PURAQ SEAWATER DESALINATION PROCESS,
Puraq Co., New Haven, CT.
L. Lazare.
Desalination, Vol. 42, No. 1, p 11-16, July, 1982. 3 Fig.

Descriptors: *Desalination, *Seawater, Process control, Temperature effects, Salinity, Heat recovery, Corrosion control.

The Puraq seawater desalination process is based on the liquid-liquid extraction of product water using a polymeric solvent, custom-synthesized to satisfy a particular set of design conditions, namely maximum seawater temperature and salinity. The solvent is a copolymer of various epoxide monomers, has a molecular weight in the range of 1800 to 3000, specific gravity of 1.10-1.15 and a viscosity under operating conditions between 10 and 40 cp. The phase diagram has a lower consulate temperature and the phase relationships roughly follow the Flory-Huggins equations for polymer solutions. The scheme is extremely simple and the equipment consists of liquid-liquid heat exchangers of the shell-and-tube type for heat recovery from the blowdown brine and product water streams, a deaerator for corrosion control and for protection of the solvent against oxygen-induced degradation, and centrifugal contactors of specially adapted design. (Baker-IVI)
W84-04927

CHANGING FACE OF DESALINATION - A CONSULTING ENGINEER'S VIEWPOINT,
Binnie and Partners, London (England).
F. C. Wood.
Desalination, Vol. 42, No. 1, p 17-25, 1982. 2 Fig, 3 Tab, 11 Ref.

Descriptors: *Desalination, *Viewpoint, Desalination, Seawater, Water quality, Marketing, Desalination apparatus, Review, Economic aspects, Performance evaluation.

The present major market for desalting plants will continue to rely mainly upon the proven MSF process until local policy dictates a need for resources conservation or the long-term merits of RO, as well as its high energy-efficiency, are well established. On the other hand, industrialized, oil-importing countries, with increasing water shortages and environmental constraints, must develop energy-efficient processes for single- and dual-purpose operation as well as improve RO membranes for desalting of seawater. The needs of small-plant users require particular consideration if the simple yet reliable plants which their circumstances demand are to be satisfied. Solar plants are likely to find their initial commercial applications in this market. (Author's abstract)
W84-04928

VERTICAL TUBE FOAM EVAPORATION FOR WATER DESALINATION,
Envirotech-Sephton Development Center, Emeryville, CA.
H. H. Sephton.
Desalination, Vol. 42, No. 1, p 27-35, July, 1982. 4 Fig, 14 Ref.

Descriptors: *Vertical tube foam evaporation, *Desalination, *Desalination apparatus, Perform-

ance evaluation, Vapor compression distillation, Economic aspects, Desalination wastes.

Vertical tube foam evaporation (VTFE) provides a method of enhancing evaporator performance substantially by increasing the brine-side heat transfer coefficient. It reduces the temperature needed to drive evaporation and the energy required; consequently, the evaporation rate or evaporator capacity is increased under constant temperature conditions. VTFE applied to multiple effect evaporators, to evaporation with vapor compression to drive the process and to waste-heat evaporation of aqueous solutions are illustrated by test data obtained with pilot plants operated under realistic process conditions and utilizing full-size distillation tubes. Retrofitting of some industrial VTE installations to permit VTFE modes of operation and additional VTFE effects within the same available temperature span would improve both the production capacity and performance ratio of such plants, utilizing the same steam source and coolant supply. The vapor compression VTFE method provides a flexible and energy-saving technique for augmenting pre-existing industrial VTE facilities by operating the VC-VTFE as a topping effect instead of or in conjunction with boiler steam. This enhances both evaporator capacity and energy efficiency. The VC-VTFE also provides energy reductions for evaporation crystallization, waste-water renovation-recycle, and desalination. Wast-heat VTFE can be integrated with many existing thermal power plants or in future designs to augment turbine efficiency, produce distilled water for boiler feed and potable or in-plant use, and for accomplishing zero discharge needs. The very low energy requirements of WH-VTFE, for pumping only, apparently reduces the cost of distilled water produced by this technology to the lowest obtainable industrially. (Murphy-IVI)
W84-04929

COURTAULDS DESALINATION PROCESS,
Courtaulds Ltd., Coventry (England).
D. C. F. Pratt.
Desalination, Vol. 42, No.1, p 37-45, July, 1982. 1 Fig.

Descriptors: *Desalination, *Heat transfer, Plastics, Distiller units, Mechanical equipment, Vapor compression distillation, Distillation.

A practical form of plastic heat transfer surface was developed for vapor recompression desalination. The process was aimed at using a cheap, polymeric heat transfer surface; using a large heat transfer surface in order to reduce the temperature differential for heat transfer, and using a particularly low compression ratio that could be provided by a fan rather than a compressor and would result in low energy consumption. The use of this surface to give very low energy vapor recompression desalination is outlined. The layout of a full-scale distiller unit is described and expected energy consumption figures are given. For full-scale plants the aim in energy consumption is around 1 MW of electricity for 1 mlgd of product. The predicted figure for a 7 mgd plant is 7.2 MW, excluding lighting. If it is assumed that a power station generates electricity at 3% efficiency and that evaporation of water requires 0.293 kWh/lb, this gives a performance coefficient of just under 40. If half the fans are driven by steam turbines taking 50 psig steam from a nearby power station, with some superheat, and the remaining energy is supplied by diesels, the performance coefficient becomes about 26 but the capital cost will benefit. (Baker-IVI)
W84-04930

DESALINATION OF BRACKISH WATER BY ELECTRODIALYSIS,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
W. P. Harkare, S. K. Adhikary, P. K. Narayanan, V. B. Bhayani, and N.J. Dave.
Desalination, Vol. 42, No. 1, p 97-105, July, 1982. 2 Fig, 5 Tab, 5 Ref.

Descriptors: *Desalination, *Electrodialysis, *Brackish water, Potable water, Membrane processes, Water supply development, Rural areas, Developing countries, Energy.

For rural areas in India, electrodialysis, being a low energy consuming technique, has an advantage over other membrane processes. The performance of an electrodialysis unit comprising interpolymer type cation and anion-exchange membrane for desalting of brackish water having different total dissolved solids up to 4000 ppm has been studied. Emphasis is placed on the energy requirements and pressure drop under different conditions. The power requirement is of a low order, with high current efficiencies at optimum operational conditions. The total pressure drop across the stack is also very low and is in the range of 1 to 2 psi. Brackish water having total dissolved solids from 1800 to about 4000 ppm can be desalted to yield potable water, with a very low energy requirement ranging from 0.5 to 2.1 kWh/cubic m. The findings are useful for the design and operation of desalination plants. (Baker-IVI)
W84-04931

PERFORMANCE OF THE 12,000 M3/D SEA-WATER REVERSE OSMOSIS DESALINATION PLANT AT JEDDAH, SAUDI ARABIA, JANUARY 1979 THROUGH JANUARY 1981,
UOP, Inc., San Diego, CA. Fluid Systems Div.
A. Muirhead, S. Beardsley, and J. Aboudiwan.
Desalination, Vol. 42, No. 2, p 115-128, August, 1982. 3 Fig, 6 Tab.

Descriptors: *Desalination, *Reverse osmosis, *Saudi Arabia, *Jeddah, Mechanical equipment, Failure, Safety, Corrosion, Membrane processes, Membranes, Resins, Seawater.

The 12,000 cu m/day seawater reverse osmosis (RO) plant built for the Saudi Arabian government and installed at Jeddah has been on-line since completion of the acceptance test in January of 1979. The system was designed to produce 12,000 cu m/day with a permeate total dissolved solids of 1000 mg/l or less. The system was designed using diesel engines as prime movers, which has had a major impact on the maintenance costs incurred during the two year operation period. Numerous problems have occurred at the system resulting from the environment, equipment not performing as expected, and substandard materials. These factors have led to premature failures, unanticipated maintenance costs and the need to replace membrane elements. Corrosion of all metal piping used to carry seawater and brine has occurred. Two of the three original Kato generators open circuited after six months of operation. Algae formed in the sea intake and the sand filter splitter box. Failure was also noted in the high pressure hose, vessel studs, the RO vessel support structure, and the membrane element. (Baker-IVI)
W84-04932

DESALINATION BY ED AND EDR - STATE-OF-THE-ART IN 1981,
Ionics, Inc., Watertown, MA.
W. E. Katz.
Desalination, Vol. 42, No. 2, p 129-139, August, 1982. 4 Fig, 10 Ref.

Descriptors: *Desalination, *Electrodialysis, *Electrodialysis reversal, Membrane processes, Brackish water, Salinity, Energy.

Recent developments in electrodialysis (ED) and electrodialysis reversal (EDR) processes have led to more extensive use of these methods for desalination. Information is provided on how EDR has achieved a major increase in the stability of membrane process performance. The growth in usage of EDR and EDR installations for brackish water desalting is reviewed in relation to the growth of desalination in general. Key new developments in ED and EDR over the past few years are reviewed. The wide spectrum of natural and man-made water salinities are noted and areas of this spectrum where ED and EDR are currently applicable are cited. In addressing the future market EDR has a number of attractions: a low energy consumption (3- to 5 kWh/1000 gal, including pumping), long term process stability with minimal pretreatment, and proven 5 to 10 year membrane life. (Baker-IVI)
W84-04933

DESALINATION BY THE IMPROVED VACUUM FREEZING HIGH PRESSURE ICE MELTING PROCESS,
New Mexico Univ., Albuquerque. Dept. of Chemical and Nuclear Engineering.
C. Y. Cheng, Y. F. Su, and D. N. Hopkins.
Desalination, Vol. 42, No. 2, p 141-151, August, 1982. 6 Fig, 2 Tab, 14 Ref.

Descriptors: *Desalination, *Vacuum freezing high ice melting process, Desalination apparatus, Desublimation, Freezing, Surface freezer, Ice pressure, Ice-brine systems.

The basic vacuum freezing high pressure ice-melting process VFPIM was studied. The VFPIM process does not require a compressor nor an absorbing solution for low pressure water vapor, nor a refrigeration loop (heat pump) to reuse the heat released in the condensation or desublimation of the low pressure water vapor in supplying the latent heat of melting ice. The process uses commercially available components and can thus be operated reliably. An extended surface freezer was found to have several advantages over the conventional spray freezer. The work input needed in the high-pressure ice-melting operation in the VFPIM process is estimated to be about 8.13 kWH. Since the work input to the compressor in the vacuum freezing vapor compression process is reported to be 15.5 kWh, the saving in work input is 7.37 kWh. Since any saving in work input also saves the work input to the refrigeration system, the total saving in the work inputs are 8.40 kWh/1000 gal. Referring to a table of elements of sections of standard aluminum pipes and their bursting pressures, it is seen that 1/4 inch, schedule 80, aluminum pipes made of 6061-T6 alloy have a bursting pressure of 22,450 psi and can be used as melter comduits. Assuming that aluminum pipe costs $1.50 per lb, the cost of the aluminum pipe for a one mgd plant is around $200,000. If an extended surface freezer is used instead of an agitated jet freezer, it is possible to save about 2 kWh/1000 gal. A multistage operation can be easily adopted in the VFPIM Process. In a multistage operation, one may still have only one counterwasher, and simply divide the freezing and melting operations into multistage operations. A significant energy saving can be accomplished by a multistage operation. Work input for the VFPIM Process to produce 1000 gal fresh water is estimated to be 30-35 kWh. (Murphy-IVI)
W84-04934

OPERATIONAL DATA ANALYSIS OF MSF DESALINATION PLANTS. A CASE STUDY OF JEDDAH I,
King Abdulaziz Univ., Jeddah (Saudi Arabia).
I. I. Kutbi, Z. A. Sabri, and A. A. Husseiny.
Desalination, Vol. 42, No. 2, p 163-197, August, 1982. 1 Fig, 29 Tab, 9 Ref.

Descriptors: *Desalination plant, *Desalination, *Operational data analysis, *Multi-stage flash desalination plant, *Jeddah I, Multi-stage flash evaporator, Operating costs, Operating policies, Performance evaluation, Desalination plants.

Monthly operation and maintenance reports of the oldest large MSF plant in Saudi Arabia, Jeddah I, are analyzed to extract information or generic operation and design problems and to seek means for the mitigation of such problems. The plant is a dual purpose plant rated at 50 MW electric power and a 1,893 cu m/d (5 mgd) water production. The accumulated records are quantified to provide estimates of equipment failure rates. Three systems are found to be the major contributors to plant outage namely, make-up water, brine recycle and sea water intake systems. Root causes of the plant unscheduled shutdowns or reductions in water production are assessed to examine generic reasons for deviations of MSF systems from standard expected performance. (Murphy-IVI)
W84-04935

ELECTROCHEMICAL STUDIES ON SEA WATER APPLIED TO DESALINATION,

Bhabba Atomic Research Centre, Bombay (India). Desalination Div.
M. K. V. Nair, B. M. Misra, and D. G. Vartak.
Desalination, Vol. 42, No. 2, p 199-207, August, 1982. 4 Fig, 5 Tab, 8 Ref.

Descriptors: *Desalination, *Seawater, *Electrochemistry, *Desalination apparatus, Spectral analysis, Hydrogen ion concentration, Calcium, Chlorine, Salinity, Alkalinity, Water properties, Chemical properties.

A study of the overall electrochemical changes taking place during the passage of current in sea water, was undertaken, with a view to utilize this for possible development of a suitable electrochemical pretreatment technique for sea water. Emphasis has been laid on the calcium removal and not for the total weight scale generated. It was also desired to obtain the optimal conditions for chlorine and acid liberation. A current of 0.10 mA/sq m appears optimum for a reasonable Ca/Mg ratio as well as the amount of calcium removal. The role of different cathode materials as well as electrode geometry has been investigated. X-ray and IR spectra of different types of scales generated are presented. (Murphy-IVI)
W84-04936

CALCULATION OF THE EXPECTED PERFORMANCE OF REVERSE OSMOSIS PLANTS,
Envirogenics Systems Co., El Monte, CA.
C. W. Saltonstall, Jr., and R. W. Lawrence.
Desalination, Vol. 42, No. 3, p 247-253, September, 1982. 1 Fig, 1 Tab, 4 Ref.

Descriptors: *Reverse osmosis, *Desalination, Design criteria, Brine, Membrane processes, Membranes, Mathematical equations, Forecasting, Prediction.

The designer of a reverse osmosis plant must forecast the brine and product stream concentrations from the membrane salt rejection and the ratio of product to feed flows (product recovery). The derivation of equations which predict these concentrations is reviewed and an average feed stream concentration between feed and brine which allows the forecasting of plant productivity at high recoveries is defined. The derived equations are contrasted with other less accurate equations which have been used in the industry. Using the equations provided, the designer can predict the concentrations of the product and brine streams leaving a RO plant from a feed composition and the measured performance of the membrane elements to be used. The designer can determine the membrane rejection required to meet a product concentration specification within specified or desirable constraints of pressure and recovery. The predicted brine concentration is of equal importance, for it allows a judgement as to whether sparingly soluble salts are liable to precipitate from solution near the brine end of the plant. (Baker-IVI)
W84-04937

RELIABILITY ANALYSIS OF REVERSE OSMOSIS PLANT,
King Abdulaziz Univ., Jeddah (Saudi Arabia).
I. I. Kutbi, Z. A. Sabri, and A. A. Husseiny.
Desalination, Vol. 42, No. 3, p 291-313, September, 1982. 18 Fig, 6 Tab, 7 Ref.

Descriptors: *Reverse osmosis, *Management planning, *Desalination, Decision making, Critical path analysis, Fault tree analysis, Seawater, Jeddah, Saudi Arabia.

The applications of the fault tree analysis techniques to reverse osmosis sea water desalination systems are illustrated. Critical failure problem areas are identified and methods of improving the performance of the RO desalination plants are recommended. Failure data has been extracted from operation and maintenance reports of the operating RO desalination plants in Jeddah, Saudi Arabia. An assessment is also made of the impact of failures and outages on the availability of the plant. The seawater intake system was found to need some improvements, such as following a strict preventive maintenance program and selection of proper materials for pumps. Poor operating conditions have been the source of trouble in the plant and the complexity of the system contributed to plant outage. To mitigate some of these problems, operators must keep adequate records, and exercise extreme care in monitoring and controlling the chemistry of the process streams. The design should accommodate human factors engineering aspects. (Baker-IVI)
W84-04938

WATER IN POLYMER MEMBRANES. PART I, WATER SORPTION AND REFRACTIVE INDEX OF CELLULOSE ACETATE,
Agricultural Research Service, Albany, CA. Western Regional Research Center
J. R. Scherer, and G. F. Bailey.
Journal of Membrane Science, Vol. 13, No. 1, p 29-41, January, 1983. 10 Fig, 32 Ref.

Descriptors: *Membrane processes, *Cellulose acetate, Polymers, Membranes, Absorption, Sorption, Films, Humidity, Desalination, Wastewater treatment.

A new technique of integrated optics is applied which allows investigation of the swelling and water absorption properties of dense symmetric films of 0.25 to 4 micrometers in thickness. The dependence of water absorption of membranes of cellulose acetate on relative humidity was determined by measuring small changes in their asymmetric waveguide properties in the visible spectral region. Simultaneous measurements of changes in film thickness provide a direct method for obtaining the change in film volume as a function of water concentration and a new measure of polymer porosity. Data are presented for a typical film fabricated from celluose acetate which illustrate the usefulness of studying water absorption by integrated optics techniques. One conclusion inferred from an interpore spacing of 50 to 60 Angstrom units is that it should be hypothetically possible to increase the number of pores in cellulose acetate membranes without increasing pore diameter and still maintain sufficient polymer interactions for stability under conditions of higher water content. (Baker-IVI)
W84-05048

3B. Water Yield Improvement

MUNICIPAL WASTEWATER REUSE FOR VARIOUS APPLICATIONS,
Katholieke Univ. Leuven (Belgium). Industrial Chemistry Section.
A. Van Haute.
Public Health Reviews, Vol. 11, No. 2, p 135-176, April-June, 1983. 4 Fig, 6 Tab, 21 Ref.

Descriptors: *Water reuse, *Reviews, Water supply development, Salinity, Calcium, Nutrients, Public health, Municipal wastewater, Wastewater irrigation, Groundwater recharge, Recreation, Potable water.

Various types of water consumption needs can be met through the use of treated wastewater. Water reuse is a planned, well-reviewed option for agriculture, recreational impoundment, industry, groundwater recharge and municipalities. Some case histories in each field of water reuse are given. In addition to increasing the supply of water available through water reuse programs, a number of other potential benefits result. These include reduced discharges of pollutants to environmentally fragile surface waters and the availability of nutrients when used for crop irrigation. The very wide spectrum of potential applications for reused water is reflected in a need for research in many diverse areas. The most critical area for reuse is potable supplies, and here the identification of potential health effects is paramount. There are also hazardous chemicals to be considered in irrigation water including soluble salts, sodium, boron or other toxic elements, and, under some conditions, bicarbonate concentrations in relation to the concentration of calcium plus magnesium. Requirements for wastewater treatment prior to application to the land by slow rate systems are variable, depending on the local regulatory agency requirements. (Baker-IVI)
W84-04804

INFLUENCE OF TILLAGE SYSTEMS ON SOIL PHYSICAL PARAMETERS AND INFILTRATION AFTER PLANTING,
Agricultural Research Service, Morris, MN. North Central Soil Conservation Research Center.
M. J. Lindstrom, and C. A. Onstad.
Journal of Soil and Water Conservation, Vol. 39, No. 2, p 149-152, March-April, 1984. 5 Tab, 14 Ref.

Descriptors: *Corn, *Tillage, *Infiltration, *Soil physical properties, Crop residues, Soil density, Permeability coefficient, Pore size, Surface runoff, Soil erosion, No-till.

Simulated rainfall trials were conducted immediately after planting during the third crop year in a continuous-corn rotation of an established tillage experiment designed to evaluate the effects of residue harvest on soil physical properties. Tillage systems were (a) fall moldboard plow, spring disk; (b) fall chisel plow, spring disk; and (c) modified no-till. Each tillage plot was split, and corn stover was harvested each year from the same half of the plots. Commerical harvesting equipment was used to remove about 70% of the above-ground plant material. Soil physical parameters measured at the time of simulated rainfall were (a) random roughness, (b) bulk density, (c) saturated hydraulic conductivity, (d) penetrometer resistance, and (e) pore size distribution. Residue harvest in the first two crop years had no measurable effect on the soil physical properties. The plots differed in bulk density, penetrometer resistance, saturated hydraulic conductivity, and pore size distribution in the Ap horizon, but not in the lower horizons. Artificial rainfall was applied at 5.6 cm/hr (2.2 in.) under relatively low energy (55% of natural rainfall energy) for 1 hr and then again for 45 min about 24 hr later. Water runoff and soil erosion differences were observed among the tillage treatments. The no-till system produced the greatest runoff regardless of residue harvesting. Soil erosion was greatest with the no-till system when residue had been harvested. The soil physical parameters measured indicated that the no-till system forms as undesirable surface condition characterized by high bulk density, high penetrometer resistance, low saturated hydraulic conductivity, and low volume of macropores, all of which can promote rapid water runoff under normal rainfall conditions. (Author's abstract)
W84-05058

PRELIMINARY QUANTIFICATION OF THE IMPACTS OF ASPEN TO CONIFER SUCCESSION ON WATER YIELD - II. MODELING RESULTS,
Utah State Univ., Logan. Coll. of Natural Resources.
For primary bibliographic entry see Field 2A.
W84-05156

3C. Use Of Water Of Impaired Quality

PUBLIC HEALTH ASPECTS OF WATER REUSE,
LunDean Environmental Co., Cincinnati, OH.
For primary bibliographic entry see Field 5D.
W84-04805

MANAGING WATER QUALITY BY MIXING WATER FROM DIFFERENT SOURCES,
Hawaii Univ., Honolulu. Dept. of Agricultural Engineering.
T. Liang, and S. Nnaji.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 48-57, January, 1983. 6 Fig, 5 Tab, 4 Ref.

Descriptors: *Water quality control, Mixing, Water supply development, Irrigation, Sugarcane, Water quality, Well water, Wells, Pumping, Economic aspects.

Mixing of water of different quality sometimes can produce water of usable quality without resorting to expensive water purifying processes. A procedure for determining the optimal manner to mix the water from a finite number of sources for quality improvement is presented. The procedure can also be used to determine the optimal strategy for purifying some of the water so that usable water can be obtained. The example calls for mixing water from three wells of varying quality such that it can be used for irrigation of sugarcane which has a moderate salt tolerance. The problem is to determine how much water should be pumped daily from each well such that the mixed water will not only satisfy irrigation needs in quantity and quality, but also can be obtained within the daily pumping time limit and at the lowest cost. Piping material and energy needed to deliver water account for most of the cost. The model developed can also be applied to a dynamic situation when the quality of the water source varies from time to time (such as treated water from a sewage plant). The model probably can be used first to determine the maximum size of the capacity of each water source such as pipe and pump. Receiving water quality information periodically from water monitors, the model can then be used to determine the amount of water to be pumped from each well such that quality standards can be met at minimal operating costs. (Baker-IVI)
W84-04955

USE OF SALINE WATER FOR SUPPLEMENTAL IRRIGATION OF SUGARCANE,
Agricultural Research Service, Hyattsville, MD.
J. R. Thomas, F. G. Salinas, and G. F. Oerther.
Agronomy Journal, Vol. 73, No. 6, p 1011-1017, November-December, 1981. 5 Fig, 7 Tab, 24 Ref.

Descriptors: *Supplemental irrigation, *Sugarcane, *Saline water, *Impaired water quality, *Texas, Groundwater, Chloride, Crop yield, Water quality, Salinity, Salinification, Plant growth.

Supplemental irrigation of sugarcane with saline ground waters may become necessary in the Lower Rio Grande Valley of Texas, since the water requirement of this crop greatly exceeds the irrigation water allotment. Experimental objectives were to determine the feasibility of using saline ground water for supplemental irrigation of sugarcane and to compare the effects of water quality on cane and sugar yields, juice quality, and the mineral composition of leaves and juice. Sugarcane cv. 'N.Co. 310' growing on Hidalgo sandy clay loam (Typic Calciustolls) was irrigated with river (EC = 1.4 mmho/cm) and a prepared saline water (EC = 4 mmho/cm) under five irrigation treatments. Yields of cane ($r = -0.85$, significant at the 0.05 level of probability), seasonal mean stalk elongation rate ($r = -0.95$, significant at the 0.01 level of probability), stalk length at harvest ($r = -0.94$, significant at the 0.01 level of probability) and electrical conductivity (ECj) of the juice ($r = -0.93$) were linearly correlated with the weighed mean salinity (ECw) of the irrigation waters in 1974, a relatively dry year. Juice Cl concentrations were linearly correlated ($r = 0.94$, significant at the 0.01 level of probability) with the Cl concentrations of the irrigation waters. Because of the leaching effect of rainfall, the effects of saline water irrigations on soil salinification and plant growth were minimized. Root zone salinity (ECe) levels were less than the threshold salinity level of 5.9 mmho/cm. Consequently, the effects of water quality on yields were small and generally nonsignificant. The average annual rainfall (67.9 to 43.9 cm) across the Lower Rio Grande Valley is probably sufficient to lower salinity if saline well waters were used for supplemental irrigation on medium texture soils. In 1974, 42.3 cm of rain after the final irrigation decreased the ECsw values at the 46 cm depth to less than 1 mmho/cm. This suggests that waters with salinity concentrations above 4 mmho/cm could probably be used to irrigate sugarcane of medium texture soils in the Lower Rio Grande Valley of Texas. (Author's abstract)
W84-04973

CORN RESPONSE TO IRRIGATION ON SURFACE-MINED LAND IN WESTERN ILLINOIS,
Illinois Univ. at Urbana-Champaign.
R. E. Dunker, I. J. Jansen, and M. D. Thorne.
Agronomy Journal, Vol. 74, No. 3, p 411-414, May-June, 1982. 1 Fig, 3 Tab, 17 Ref.

Descriptors: *Land reclamation, *Strip mine wastes, *Irrigation water, *Corn, *Illinois, Water stress, Strip mine lakes, Crop yield, Wheel spoil, Mine soils.

Moisture stress is one of the major yield limiting factors for row crops grown in the field on newly constructed mine soils. Response of corn (Zea mays L.) to irrigation on recently constructed mine soils in west-central Illinois was studied over a two-year period to determine the feasibility of utilizing water from surface-mine lakes for irrigation of row-crops on reclaimed land. Two constructed soils, one with 45 cm of topsoil replaced on wheel spoil and one consisting of wheel spoil only, were studied. Both soils are Typic Udorthents. A lake formed in an abandoned mine incline supplied water to a solid-set overhead revolving impact sprinkler system, randomly placed within each soil treatment which applied 3.8 cm of water each week to the irrigated treatment until physiological maturity. Irrigation significantly increased corn yield in 1979 by 2,260 kg/ha for topsoil over wheel spoil and 2,630 kg/ha for wheel spoil only. The weather pattern in 1980 was distinctly different than in 1979 with severe stress during anthesis in 1980. Corn yield response to irrigation in 1980 ranged from 3,450 kg/ha to 6,030 kg/ha among soil treatments. Topsoil replacement resulted in significant yield increases with irrigation in both years. Without irrigation topsoil replacement resulted in a yield increase in 1979 and a yield reduction in 1980. The data suggest that corn will perform well under favorable moisture conditions on newly constructed soils but is quite sensitive to moisture stress. Yields can be increased by irrigation using good quality water from surface mine lakes to alleviate this moisture stress. (Author's abstract)
W84-04982

UTILIZATION OF RECYCLED IRRIGATION WATER ON MARIGOLDS FERTILIZED WITH OSMOCOTE AND CONSTANT LIQUID FERTILIZATION,
California State Univ., Fresno.
For primary bibliographic entry see Field 3F.
W84-05072

BACTERIOLOGICAL QUALITY OF CROPS IRRIGATED WITH WASTEWATER IN THE XOCHIMILCO PLOTS, MEXICO CITY, MEXICO,
Universidad Nacional Autonoma de Mexico, Mexico City. Dept. de Quimica de la Atmosfera y Estudios del Agua.
I. Rosas, A. Baez, and M. Coutino.
Applied and Environmental Microbiology, Vol. 47, No. 3, p 1074-1079, May, 1984. 3 Fig, 5 Tab, 30 Ref.

Descriptors: *Bacterial analysis, *Crop production, *Wastewater irrigation, *Xochimilco, *Mexico, *Mexico City, *Irrigation effects, Irrigation practices, Coliforms, Vegetables, Environmental effects.

Xochimilco county plots (Mexico City), one of the most fertile agricultural areas in the Valley of Mexico, produce a large portion of the fresh vegetables consumed in the city. These plots are generally irrigated with domestic wastewater, and for this reason, it was deemed important to examine and evaluate the bacteriological quality of the water, soil, and vegetables from these plots that are harvested and marketed. The soils were also examined for the classical parameters such as nitrates, ammonia, etc., and organic matter and texture. The crops selected for this study were radishes, spinach, lettuce, parsley, and celery because they are usually consumed raw. The highest bacterial counts were encountered in leafy vegetables, i.e., spinach (8,700 for total coliform and 2,400 for fecal coliform) and lettuce (37,000 for total coliform and 3,600 for fecal coliform). Statistically significant differences in bacterial counts between rinsed and unrinsed edible portions of the crops were observed. In rinsed vegetables high densities of fecal coliform were detected, indicating that their consumption represents a potential health hazard. The total coliform values found in irrigation water ranged from 40,000 to 290,000, and for fecal coliform the values ranged from 500 to 3,000. (Author's abstract)
W84-05280

3D. Conservation In Domestic and Municipal Use

RESULTS OF THE IMPLEMENTATION OF THE DIRECTIVE ON RATIONAL WATER USE IN THE 1981-1985 FIVE-YEAR PLAN (ERGEBNISSE BEI DER VERWIRKLICHUNG DER DIREKTIVE ZUR RATIONELLEN WASSERVERWENDUNG IM FUNFJAHRPLAN 1981 BIS 1985),
Ministerium fuer Umweltschutz and Wasserwirtschaft, Berlin (German D.R.).
G. Voigt.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 147-148, May, 1983.

Descriptors: *East Germany, *Water conservation, *Water use, Water supply, Water demand, Industrial water, Domestic water, Municipal water, Water pollution control.

The Tenth Party Conference (TPC) of the German Democratic Republic charged water management with providing an adequate and stable water supply in the long term, the key to which is ever-increasing rational water use (RWU). Measures instituted so far as a result of TPC decisions include a 1982 comprehensive political and ideological study that set RWU goals for all segments of the economy, the development of 119 RWU concepts to aid in planning and management, the establishment of annual RWU plans for industrial companies, preparation of a document pertaining to all relevant government agencies on goals for research and development, institution of government standards for industrial water use, and, by the end of 1982, reduction in specific water demand in 1981 plus 1982 of 8%, rise of not more than 1% in water demand for all areas of the economy, absolute industrial water demand decrease since 1980 of 100 million cu m (with some industries performing much better than others), reduction in wastewater pollution in 1982 of 615,000 population equivalents, increases in water supply of 28.5 and 74.2 million cu m for surface and groundwater, respectively. Future efforts will concentrate on further reductions in water demand (especially in those industries that have not performed well so far), establishment of control procedures, and development of government standards for recycling valuable chemicals. (Gish-IVI)
W84-04793

KDT INFORMATION CONFERENCE ON ECONOMIC EVALUATION OF REDUCTION OF THE WASTEWATER LOAD ON WATER RESOURCES (INFORMATIONSTAGUNG DER KDT ZUR OKONOMISCHEN BEWERTUNG DER ABWASSERLASTSENKUNG IN DEN GEWASSERN),
For primary bibliographic entry see Field 5D.
W84-04794

ECONOMIC EVALUATION OF WATER-MANAGEMENT PROCEDURES FOR THE IMPLEMENTATION OF RATIONAL WATER USE AND WASTEWATER LOAD REDUCTION FOR WATER RESOURCES (VOLKSWIRTSCHAFTLICHE BEWERTUNG WASSERWIRTSCHAFTLICHER MASSNAHMEN ZUR DURCHSETZUNG DER RATIONELLEN WASSERVERWENDUNG UND ABWASSERLASTSENKUNG IN DEN GEWASSERN),
D. Bohler.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 150-152, May, 1983. 4 Tab, 3 Ref.

Descriptors: *Water management, *Economic aspects, *Water use, Mathematical equations, Economics, Political aspects, Wastewater load reduction, Social aspects.

Water-management procedures (WMP) must be economically evaluated because every utilization made of water resources has an impact on subsequent utilizations. Not operational effectiveness, but effectiveness with regard to the political economy, should be the deciding factor in the order of precedence and sequence of operation of WMP. However, every economic evaluation must be based on scientific evaluation of the water in its environment and its potential use. Mathematical equations are given to quantify economic benefits (based on increased results for the political economy and for the business, taking influencing factors into account), economic effect of operating expenses (increases in economic results over decreases in economic results), and economic effect on one-time expenditures (one-time expenditures over economic results increase determined by the first equation). The final evaluation is based on the results of the equations plus a judgment of nonquantifiable verbal criteria: comparison of equation results with given norms, results from other similar procedures, and optimal values; and estimation of the procedure's effects on partly or nonquantifiable political, military, social, cultural, economic, and scientific criteria (e.g., public health, ensuring an adequate water supply, improvement of working and living conditions of workers, raising water self-purification potential, plant automation). (Gish-IVI)
W84-04795

INCENTIVES AND DISINCENTIVES FOR WATER CONSERVATION IN THE CALIFORNIA STATE WATER POLICYMAKING PROCESS,
California Univ., Los Angeles. Dept. of Political Science.
A. Engelbert, and J. Munro.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84 171123, Price codes: A10 in paper copy, A01 in microfiche. Completion Report, January, 1984. 171 p, 7 Fig, 4 Append. Project No. OWRT C-90175-C (0408) (1), Contract/Grant No. 14-34-0001-0408.

Descriptors: *California, *Water conservation, Political aspects; Policymaking; *Institutional constraints; Alternative water use; *Administrative decision, *Decision making, Water policy, *State government, Incentives, Disincentives.

This study focuses on California's political and policymaking environment for water conservation with particular emphasis on the years 1977 through 1980. The major approaches to water conservation are examined in the setting of California's major political conflicts. The positions taken by major interest groups on significant water conservation issues are assessed. The distinctive aspects of the legislative organization and process for water conservation are examined in the context of four major voting blocs. The major pieces of water conservation legislation for the 1977-1980 period are analyzed in terms of educative, incentive, regulatory and institutional change strategies. Finally, the role of the governor in the water conservation policymaking process is highlighted. How California proceeds with its political decisionmaking processes for water conservation has major implications for national and state water policies in the semi-arid West.
W84-04832

3E. Conservation In Industry

RESULTS OF THE IMPLEMENTATION OF THE DIRECTIVE ON RATIONAL WATER USE IN THE 1981-1985 FIVE-YEAR PLAN (ERGEBNISSE BEI DER VERWIRKLICHUNG DER DIREKTIVE ZUR RATIONELLEN WASSERVERWENDUNG IM FUNFJAHRPLAN 1981 BIS 1985),
Ministerium fuer Umweltschutz and Wasserwirtschaft, Berlin (German D.R.).
For primary bibliographic entry see Field 3D.
W84-04793

ECONOMIC EVALUATION OF WATER-MANAGEMENT PROCEDURES FOR THE IMPLEMENTATION OF RATIONAL WATER USE AND WASTEWATER LOAD REDUCTION FOR WATER RESOURCES (VOLKSWIRTSCHAFTLICHE BEWERTUNG WASSERWIRTSCHAFTLICHER MASSNAHMEN ZUR DURCHSETZUNG DER RATIONELLEN WASSERVERWENDUNG UND ABWASSERLASTSENKUNG IN DEN GEWASSERN),
For primary bibliographic entry see Field 3D.
W84-04795

EVALUATION OF OPERATIONAL PROCEDURES FOR THE IMPLEMENTATION OF RATIONAL WATER USE FROM THE POINT OF VIEW OF AN INDUSTRIAL PLANT (BEWERTUNG BETRIEBLICHER MASSNAHMAN FUR DIE DURCHSETZUNG DER RATIONELLEN WASSERVERWENDUNG AUS DER SICHT EINES INDUSTRIEBETRIEBES),
VEB Papier und Kartonwerke, Schwedt an der Oder (German D.R.).
H. Biernath.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 155-156, May, 1983. 3 Fig.

Descriptors: *Water conservation, *Pulp and paper industry, Industrial water, Water use, Recycling, Water reuse, Filtration, Wastewater treatment, Water use.

The Schwedt VEB Paper and Cardboard Works, German Democratic Republic (GDR), is one of the largest water users (47,000 cu m/day) in the Frankfurt (Oder) District. In paper manufacturing valuable materials, i.e., fiber, are recycled through filtration; the filter cake, when dried, is used for paper/card. At Schwedt, water is circulated three times. In the primary cycle, the filtrate is reused without further treatment. In the second cycle, sedimentation (skimmer) or flotation occurs with chemical supplements, and the resulting solid materials are returned to production, while the water goes to the sewer. In the third cycle, wastewater is treated in a sedimentation facility (funnel), after which the procedure is the same as in cycle two. Schwedt is the largest user of recycled paper in the GDR at 400 tonnes/day, and this presents special wastewater treatment problems. The morphological structure of single fibers in suspended recycled paper is such that a high proportion of dust and slime appears in wastewater and overloads the treatment facility. Its components, such as plastic, foil, wire, wood, cause pollution in the plant water circulation and hinder the reuse of wastewater. In 1979, the plant began a study of its water management in order to formulate a concept for future development. It was decided that the criterion for wastewater treatment should not be simply the avoidance of penalty payments but considerations of technology, sewer requirements, and downstream water users. (Gish-IVI)
W84-04796

3F. Conservation In Agriculture

VERIFICATION OF LATERAL PERCOLATION LOSSES FROM IRRIGATED RICE FIELDS BY A NUMERICAL MODEL,
Land Resources Development Centre, Surbiton (England).
S. H. Walker, and K. R. Rushton.
Journal of Hydrology, Vol. 71, No. 3/4, p 335-351, March, 1984. 6 Fig, 4 Tab, 21 Ref.

Descriptors: *Lateral percolation, *Water loss, *Numerical models, *Rice fields, *Irrigation practices, Irrigation efficiency, Percolation, Percolating water, Bunds, Groundwater movement, Groundwater level, Geohydrology.

Previous field studies have identified lateral percolation as the main cause of low water-use efficiency in certain irrigated rice fields. The mechanism and magnitude of flow through the bund and in the underlying aquifer for a representative problem are examined. A numerical model is used to simulate the flow conditions. The electrical analogue provides a numerical model of lateral percolation from irrigated rice fields which can explain the wide range of seepage and percolation rates reported by field observers, often working under apparently similar conditions. The rates can vary not only with soil texture, but also with depth of water in the fields and seasonal fluctuations of the regional water table. Thus the same site may lose different amounts of water at different times of the year; clay soils with a low water table may lose as much as freely drained soils with a high water table; and high or rapidly rising water tables may also cause the very low, zero or even negative losses usually attributed to artesian conditions. In particular, the model demonstrates the mechanism whereby large losses through bunds do occur and this lateral percolation is seen to be a complex function of hydraulic head and bund geometry which merits further study. In the laboratory, different approaches may be needed to model Bouwer's fringe and partially saturated effects in both the bund and the aquifer, but different bund geometries can be tested using existing numerical models. In the field, additional careful measurements are needed to test water-table positions at crucial points in the bund and aquifer, and to determine whether pressure is atmospheric beneath the rice fields. Although the results do not cover every situation, they offer a coherent and logical explanation for reported field losses, and provide an understanding of the important processes. They show in particular that the very low efficiencies frequently observed on irrigation systems might be substantially improved by better water-management practices at both the tertiary and farm levels. Wastage by lateral percolation could be greatly reduced by maintaining shallow depths of water in the rice fields. (Murphy-IVI)
W84-04867

EVAPOTRANSPIRATION LOSSES OF TOMATOES UNDER DRIP AND FURROW IRRIGATION,
California Univ., Davis. Dept. of Land, Air and Water Resources.
W. O. Pruitt, E. Fereres, D. W. Henderson, and R. M. Hagan.
California Agriculture, Vol. 38, No. 5-6, p 10-11, May-June, 1984. 2 Fig, 2 Tab. OWRT Project A-076-CAL and Water Resources Center Project UCAL-WRC-W-572.

Descriptors: *Furrow irrigation, *Evapotranspiration, *Drip irrigation, Crop yield, Tomatoes, Irrigation, Water conservation, Cost analysis.

During the 1979-1980 growing seasons, a study was conducted to measure evapotranspiration of processing tomatoes under drip and furrow irrigation. The drip-irrigation system consisted of microtube emitters with an inside diameter of 0.035 inch placed every 18 inches on the laterals, each delivering about 0.7 gallon per hour. In the 1980 season, evapotranspiration in the furrow-irrigated lysimeter averaged 30% higher for the first day or two after an irrigation, but, from the fifth day on, it was about 10% higher in the drip-irrigated lysimeter. Drip irrigation has been shown to be capable of increasing yields beyond those achieved by surface irrigation methods under some conditions. This was apparently the case in the 1979 field study, when the drip-irrigated plots yielded 19% more ripe fruit than furrow-irrigated plots. For row crops, the possibility of reducing evaporation losses from soil by using drip irrigation is quite small, although improvements in buried drip systems that do not wet the soil surface may offer additional savings. For most agricultural soils, however, the reduction in evaporation losses alone by changing to drip does not justify the economic investment necessary, because the yield achievable with drip irrigation will not be substantially higher than yield under a well managed surface irrigation system. (Baker-IVI)
W84-04888

INFLUENCE OF WINDBREAK-SHELTER ON SOYBEAN PRODUCTION UNDER RAINFED CONDITIONS,
Nebraska Univ.-Lincoln. Dept. of Forestry, Fisheries and Wildlife.
S. N. Ogbuehi, and J. R. Brandle.
Agronomy Journal, Vol. 73, No. 4, p 625-628, July-August, 1981. 2 Fig, 5 Tab, 15 Ref.

Descriptors: *Crop yield, *Water use efficiency, *Windbreaks, *Nebraska, Shelterbelts, Wind, Soybeans, Evaporation, Water use.

Wayne soybeans were planted on 19 May during 1978 and 1979 growing seasons under windbreak sheltered and exposed conditions. Shelter from the wind was provided by a system of east-west oriented shelterbelts, 6 m high, 60% dense, and consisting of green ash, Austrian pine, and eastern red cedar. The prevailing winds in Nebraska during the summer study months come mainly from the south. The soil was a Typic Argiudoll. There were no statistically significant differences between treatments in available soil water and plant water use. The main effect of the windbreak was reduction of surface windspeed in the sheltered zone, causing changes in the microclimate that have been proven conducive to improved crop growth and yield. Shelter increased bean yield above that of the exposed plants by 20 and 26% in 1978 and 1979, respectively. Under rainfed conditions, increased water use efficiency and significant increases in bean yield can be expected from windbreak sheltered soybeans. (Baker-IVI)
W84-04965

CANOPY TEMPERATURES, WATER USE, AND WATER USE EFFICIENCY OF CORN GENOTYPES,
Kansas Agricultural Experiment Station, Manhattan. Evapotranspiration Lab.
For primary bibliographic entry see Field 2I.
W84-04966

INFLUENCE OF IRRIGATION AND RHIZOBIUM JAPONICUM STRAINS ON YIELDS OF SOYBEANS GROWN IN A LAKELAND SAND,
Idaho Univ., Moscow. Dept. of Plant and Soil Sciences.
R. L. Mahler, and A. G. Wollum, II.
Agronomy Journal, Vol. 73, No. 4, p 647-651, July-August, 1981. 2 Fig, 7 Tab, 24 Ref.

Descriptors: *Soybeans, *Irrigation effects, *Crop yield, Soil-water-plant relationships, Rhizobium, Soil texture, Soil water.

Under existing management technology, Lakeland sands (Typic Quartzipsamments) produce low yields of soybeans (Glycine max (L.) Merr.) in North Carolina. These soils have an available water holding capacity of only 4.0% on a weight basis and as a result require about 2.5 cm of water every 5 to 6 days during the growth season to produce acceptable crop yields. In addition, Lakeland sands usually have extremely low or a totally nonexistent indigenous population of Rhizobium japonicum. Information on irrigation and nodulation effects is needed to make these soils more productive. The objectives of this study were to investigate the influence of irrigation and inoculation with different R. japonicum strains on yields of soybeans grown in a Lakeland sand. The study was conducted at the Sandhills Research Station at Jackson Springs, North Carolina. Additional nonirrigated plots inoculated with strains 31, 110, and 122 were initiated on finer textured North Carolina soils for comparative purposes to the Lakeland sand. Soil moisture treatments included plots not irrigated and plots irrigated each week with 2.5 cm of water. The five inoculation treatments consisted of a set of noninoculated plots and plots inoculated with strains of R. japonicum representing serogroups 31, 76, 110, and 122 at the rate of 5,000,000 cells per cm of soybean row. Numbers of soil rhizobia were monitored throughout the study using a plant infection and MPN technique. Irrigated soybean seed yields were significantly greater when inoculated with rhizobia of either serogroup 110 or 122 than yields from noninoculated but irrigated plots. Inoculation without irrigation did not increase soybean yields. It was also observed that inoculated, irrigated soybeans had greater nodule mass and numbers of nodules than the nonirrigated and/or noninoculated plots. All four serogroups used in the study adequately nodulated soybean roots under irrigation and produced fewer nodules on soybean roots in the nonirrigated plots. On the basis of seed yield, strain ranking from best to worst was: 122 > 110 > 31 > 76. The noninoculated controls yielded higher than serogroup 76 but less than those soybeans in plots inoculated with serogroup isolate 31. (Author's abstract)
W84-04967

WATER MANAGEMENT AND NITROGEN FERTILIZATION OF RATOON CROP RICE,
Louisiana State Univ., Crawley. Rice Experiment Station.
D. B. Mengel, and F. E. Wilson.
Agronomy Journal, Vol. 73, No. 6, p 1008-1010, November-December, 1981. 1 Fig, 3 Tab, 8 Ref.

Descriptors: *Water management, *Fertilizers, *Rice, *Ratoon cropping, Flood irrigation, Crop yield.

Ratoon cropping is the practice of obtaining a second crop from tillers originating from the stubble of a harvested crop. Ratooning of rice offers a unique opportunity to maximize the use of land during a growing season which is too short to grow two planted crops, or to utilize residual soil moisture in both irrigated or dry land tropical areas. Field experiments were conducted for 3 years to determine the effect of two water management systems and N fertilization on the yield and milling quality of ratoon crop rice. The experiments were conducted on a Crowley silt loam (Typic Albaqualf) soil. Applying a shallow (5 to 8 cm) continuous flood immediately after harvest of the planted crop was superior to a series of short-term floodings to provide adequate moisture for regrowth, followed by a continuous flood when the ratoon tillers were 10 to 15 cm tall (approximately 4 weeks after planting). Grain yield averaged 68% higher where the immediate flood was applied. Under both water management regimes a significant increase in plant height and grain yield was observed when N fertilizer was applied. Time of flooding and N fertilization had no effect on milling quality of the ratoon crop. (Moore-IVI)
W84-04972

ALFALFA YIELD AND WATER USE WHEN FORCED INTO DORMANCY BY WITHHOLDING WATER DURING THE SUMMER,
Agricultural Research Inst., Nicosia (Cyprus). Soils and Water Use Section.
C. Metochis, and P. I. Orphanos.
Agronomy Journal, Vol. 73, No. 6, p 1048-1050, November-December, 1981. 1 Fig, 1 Tab, 12 Ref.

Descriptors: *Alfalfa, *Crop yield, *Water use efficiency, *Dormancy, *Cyprus, Irrigation efficiency, Air temperature, Water conservation.

Under the hot (air temperature reaching 40 C) and dry conditions of the inland areas of Cyprus, alfalfa (Medicago sativa L.) yields decline markedly in July to August. Water-use efficiency (kg DM/cu m of water taken up) decreases from 2.25 to 2.85 in March through May to 0.05 to 0.65 kg/cu m in July through August. This study evaluated several alternatives for increasing water-use efficiency for alfalfa production. Not irrigating the alfalfa for one growth period in July reduced yield during that period by 68%. However, not irrigating for a second or a third growth period resulted in no forage yield during these periods. When irrigation was resumed, plots not irrigated for one or two growth periods yielded as much as plots irrigated at all growth periods, but plots not irrigated for three growth periods produced 20% less yield during the first period following resumption of irrigation. In the following growth periods, however, these yielded as much as plots irrigated at all growth periods. Discontinuing irrigation for the three growth periods of July to August reduced annual dry matter yield to 17,700 kg/ha compared to 21,500 kg/ha when adequate water was applied throughout, but saved 610 mm of irrigation water out of a normal annual irrigation requirement of 1,400 mm. As a result, water-use efficiency in 1978-1979 increased from 1.32 kg DM/cu m of water taken up when adequate irrigation was applied throughout the growing season to 1.60 when irrigation was withheld for the three growth periods of July to August. The corresponding figures for 1979-1980 were 1.41 and 1.81, respectively. (Author's abstract)
W84-04974

CONSUMPTIVE WATER USE BY SUB-IRRIGATED TURFGRASS UNDER DESERT CONDITIONS,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
W. R. Kneebone, and I. L. Pepper.
Agronomy Journal, Vol. 74, No. 3, p 419-423, May-June, 1982. 4 Fig, 3 Tab, 9 Ref. OWRT project B-035-WYO.

Descriptors: *Consumptive use, *Water use, *Turf grasses, *Subirrigation, *Deserts, Arid lands, Climate, Evaporation demand, Irrigation practices, Water table.

Irrigation is essential for turfgrass growth in the arid southwest. Water conservation is equally essential. To irrigate properly, levels of consumptive water use and the factors which affect them must be known. This study evaluated effects of management, local climate, species, and cultivars upon water use. Three bermudagrasses (Cynodon dactylon L. Pers.), a zoysiagrass (Zoysia japonica Steud.), St. Augustinegrass (Stenotophrum secundatum (Walt.) Kuntzel), and tall fescue (Festuca arundinacea Schreb.) were grown in a local washed mortar sand in percolation lysimeters with measured subirrigation at Tucson, Ariz. There were no significant differences in consumptive water use among the bermudagrasses and zoysiagrass at either of two managements. Raising the water table 10 cm and overseeding with annual ryegrass in winter significantly increased consumptive use. St. Augustinegrass and tall fescue used significantly more water than the bermudagrass and zoysiagrass. Consumptive water use varied with evaporative demand as measured by Class A pan. Consumptive use values expressed as percentage of evaporative pan losses ranged from 42 to 80% depending upon management and grass. Mean annual percentages were 46 for bermudagrasses and zoysiagrass, 58 for St. Augustinegrass, and 64 for tall fescue grown with the same water table. The same percentage was 58 for bermudagrasses and zoysiagrass overseeded with ryegrass in winter and maintained with a 10 cm higher water table. (Author's abstract)
W84-04983

RESPONSE OF TOMATOES TO N AND WATER APPLIED VIA A TRICKLE IRRIGATION SYSTEM. II. WATER,
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Chemistry and Plant Nutrition.
B. Bar-Yosef, and B. Sagiv.
Agronomy Journal, Vol. 74, No. 4, p 637-639, July-August, 1982. 4 Fig, 6 Ref.

Descriptors: *Trickle irrigation, *Tomatoes, *Crop yield, Irrigation rate, Soil water potential, Crop management, Nitrogen, Evaporation.

The objective of the study was to relate tomato fruit yield and N uptake to water application rates via a trickle irrigation system at given N rates to total water potential in the soil root volume. This information is needed to improve tomato cropping management under point source irrigation. The experiments were conducted on sandy soils at three different locations in Israel and included combinations of several daily N and water application rates, and two irrigation intervals. Fruit yield responded linearly to increasing total irrigation rates (Qw) up to 80% of the accumulated evaporation from a U.S. Class A pan (Ep), the slope of the response line being 15 metric tons/ha for each 10% change in Qw/Ep. The optimum average N concentration in the irrigation solution was determined

to be 130 ppm N, below which yields and growth were inhibited and above which the soil water potential (Theta) decreased, thus increasing the dry matter content of the fruit. A decrease in Theta from -50 to -150 centibars appreciably decreased fresh fruit yield; a further decrease in Theta caused a slower decrease in fresh fruit yield. (Author's abstract)
W84-04985

FORAGE CORN RESPONSE TO SEVERAL TRICKLE IRRIGATION AND FERTILIZATION REGIMES,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
M. Yanuka, Y. Leshem, and A. Dovrat.
Agronomy Journal, Vol. 74, No. 4, p 736-740, July-August, 1982. 7 Fig, 3 Tab, 29 Ref.

Descriptors: *Trickle irrigation, *Corn, *Fertilizers, Forages, Evapotranspiration, Irrigation effects, Crop yield, Soil water.

Trickle irrigation has the advantages of better water and nutrient control (frequent supply as needed by the plant) and less outside disturbance that may cause lower water and nutrient use efficiencies (wind, loss of pressure in irrigation pipes). The yield level of forage corn (Zea mays L.), cv. Newe Ya'ar 170 at a density of 110,000 plants per hectare, and its nutrient and moisture uptake were determined, as affected by the application of different amounts of irrigation water when plant nutrients in the soil were sufficient for maximum growth. Crop water requirement (WR) was based on estimates of ET/Eo (ET = crop evapotranspiration and Eo = Class A pan evaporation) multiplied by Em (measured Class A pan evaporation). In order to derive the different irrigation treatments, WR was multiplied by a variable K, i.e., 1.5, 1.0, or 0.5, giving the total amounts of water applied by trickles of 693, 459, or 230 mm, respectively over an experimental period of approximately 100 days. The averages of daily water tension in several soil profiles, daily dry matter production rates, cummulative dry matter yield, and daily nutrient (N, P, K) uptake by the plant were measured. The ratio between dry matter yield and ET/Eo was approximately 290 kg/ha/day for all treatments. This value is high in comparison with those reported in the literature. The response curve of dry matter yield vs. evapotranspiration began near the origin and was linear. The maximum dry matter yield, 32,440 kg/ha, was obtained with an average soil water tension of 4 centibars at 0 to 150 cm soil depth and average NO3-N concentration of about 80 ppm in soil solution to a depth of 30 cm during the period of most active N uptake. Average P and K concentrations in the upper 30 cm at that time were 20 and 80 ppm, respectively. The maximum rate of dry matter production was 660 kg/ha/day at the time of grain filling. Trickle irrigation allowed efficient control of the fertilizer-water-soil system, maintaining high water and nutrient availability to the crop. (Moore-IVI)
W84-04987

MOISTURE DEFICITS AND GRAIN SORGHUM PERFORMANCE: EFFECT OF GENOTYPE AND LIMITED IRRIGATION STRATEGY,
International Rice Research Inst., Los Banos, Laguna (Philippines). Dept. of Agronomy.
D. P. Garrity, D. G. Watts, C. Y. Sullivan, and J. R. Gilley.
Agronomy Journal, Vol. 74, No. 5, p 808-814, September-October, 1982. 6 Fig, 3 Tab, 13 Ref.

Descriptors: *Sorghum, *Irrigation effects, *Water stress, Crop yield, Drought resistance, Water allocation, Irrigation timing, Water conservation.

The response of three selected sorghum (Sorghum bicolor (L.) Moench) hybrids to a wide range of timings and intensities of drought stress were studied in field experiments on a sandy soil (Typic Ustipsament) in west central Nebraska. A modified line source sprinkler irrigation gradient was used to create the treatments. Yield reduction (41 to 45%) resulting from the gradual intensification of stress over the entire season were large but very similar among genotypes. Greater genotypic differences occurred in treatments in which irrigation was limited during only one or two growth periods. The genotypic rankings for yield were quite consistent over the range of treatments, with the hybrid of highest yield potential (RS 626) usually continuing to demonstrate superior yields under drought stress. The hybrid (NB 505) of lowest yield potential did not show a comparatively greater drought resistance (i.e., a lower percentage yield reduction) under severe stress. Grain yield tended to be linearly related to seasonal net water application and to various in the percent of the soil water deficit that was replaced each week, regardless of variety or the growth stage(s) at which irrigation was limited. The timing of irrigation was quite critical with large differences in the response of each hybrid to the same quality of seasonal water applied under varying strategies. The data for both years and all genotypes indicated that an optimal strategy for allocating water under limited irrigation would be to apply a constant fraction of the crop's maximum water usage each week, allowing stress to gradually and progressively intensify throughout the season. Yield reductions will occur but these will tend to be lower per unit of irrigation water saved than when irrigation is limited only in individual growth periods. (Author's abstract)
W84-04988

MOISTURE DEFICITS AND GRAIN SORGHUM PERFORMANCE: EVAPOTRANSPIRATION-YIELD RELATIONSHIPS,
For primary bibliographic entry see Field 2D.
W84-04989

EFFECTS OF PLANT AND ROW SPACING ON DRYLAND SOYBEAN YIELD AND WATER-USE EFFICIENCY,
Science and Education Administration, Mandan, ND. Northern Great Plains Research Center.
J. Alessi, and J. F. Power.
Agronomy Journal, Vol. 74, No. 5, p 851-854, September-October, 1982. 3 Fig, 3 Tab, 18 Ref.

Descriptors: *Soybean, *Water use efficiency, *Crop yield, *Row spacing, *Plant spacing, Drought, Soil water, Available water, Water stress.

The question of water availability and water use rate, as affected by planting geometry, becomes of major significance to soybean production in drier regions or drier years. In such situations, water availability may assume greater importance than availability of solar radiation in limiting the growth of most crops. Each spring, 1976 through 1979, soybeans were seeded on Temvik silt loam (fine-silty, mixed Typic Haploborolls) at Mandan, N.D., in row widths of 15, 45, and 90 cm, and at within-row spacings of 11, 15, and 23 cm, which resulted in plant populations of 48,000 to 580,000 plants/ha. Soil water depletion by soybeans was generally confined to the upper 90-cm soil depth. Average (4-year) water use was 23.6 cm, and was not significantly affected by plant spacing. In 2 of the 4 years, total water use was greatest and average soybean yields were least from the 15-cm row width. Within-row spacing affected yields in only 1 of the 4 years. Water-use efficiency was least for 15-cm rows in 3 of the 4 years. Planting in 15-cm rows enhances water use prior to flowering. In extreme drought situations, this enhanced early-season water use leaves less water available for pod-fill, and seed yields may be reduced accordingly. Under less severe water stress, plant and row spacing has no affect on soybean yield. Narrow rows may be beneficial for soybean production when water is not restricted; may have no effect upon soybean yields when moderate water stress is encountered; and may reduce soybean yields under extreme water stress situations. (Moore-IVI)
W84-04990

RESPONSE OF DRIP-IRRIGATED SUGARCANE TO DROUGHT STRESS,
Lihue Plantation Co. Ltd., Kauai, HI.
P. H. Koehler, P. H. Moore, C. A. Jones, A. D. Cruz, and A. Maretzki.
Agronomy Journal, Vol. 74, No. 5, p 906-911, September-October, 1982. 6 Fig, 2 Tab, 20 Ref.

Descriptors: *Drip irrigation, *Sugarcane, *Drought stress, *Hawaii, Crop yield, Plant water potential, Soil water, Plant growth, Irrigation requirement.

Though drip irrigation is used on more than half of the irrigated sugarcane (Saccharum spp. hybrid) in Hawaii, the effects of drought stress on the growth and yield of drip-irrigated sugarcane has not been investigated extensively. This study reports the effects of a single period of drought stress on the growth and metabolism of cultivar H62-4671 during vegetative growth in drip-irrigated fields during the 1st year of a normal 2-year crop in five fields at Kekaha Sugar Company, Kauai, Hawaii. The plants ranged from 5.4 to 9.8 months of age at the beginning of the experiment. Water depletion from the soil profile, leaf water potential (Psi l), leaf solute potential (Psi pi), leaf pressure potential (Psi rho), staik elongation, plant sugar, K, and amino acid concentrations were monitored at 1200 to 1400 hour during a 5- or 6-week period of drought stress. In three of four fields, soil water extraction was limited by low soil water content after cumulative profile water depletion of approximately 120 mm. Stalk elongation was strongly correlated to Psi l and cumulative soil water depletion. Stalk elongation of plants in drought-stressed plots was less than 80% that of plants in well-watered plots after only 50 mm of cumulative soil water depletion. During drought the concentration of potassium and reducing sugars in the leaf blade increased, but the concentrations of sucrose and free amino acids changed little. None of these metabolites changed in the stem appex. The results indicate that a serious reduction in stalk elongation occurs prior to a reduction in the rate of soil water depletion, a change in the false-color infrared signature of the canopy, or large changes in Psi l, Psi pi, leaf and meristem sugar, K, and amino acid concentrations. The results emphasize the importance of maintaining normal irrigation intervals with drip-irrigated sugarcane cv. H62-4671. (Author's abstract)
W84-04991

EFFECT OF CROP RESIDUE MANAGEMENT AND TILLAGE ON WATER USE EFFICIENCY AND YIELD OF WINTER WHEAT,
Agricultural Research Service, Pullman, WA.
V. L. Cochran, L. F. Elliott, and R. I. Papendick.
Agronomy Journal, Vol. 74, No. 6, p 929-932, November-December, 1982. 1 Fig, 4 Tab, 15 Ref.

Descriptors: *Wheat, *Tillage, *Water use efficiency, *Crop yield, *Residue management, Phytotoxins, Water storage, Drill seeding.

Direct drilling of winter wheat (Triticum aestivum L.) into surface cereal residues reduces soil erosion but frequently has resulted in stunted plants and lower grain yields than conventional planting methods. Phytotoxins produced during decomposition of surface crop residues have been implicated as the cause of these reduced yields. Field plots were established on spring and winter wheat stubble to compare plant stands, water storage, grain yields, and water-use efficiency between direct drill seeded and conventionally seeded winter wheat. Residue management treatments included: standing stubble, complete residue removal, moving the crop residue from the seed row, and residue incorporation. New sites were used each year with the spring and winter wheat stubble maintained on Naff silt loam (fine-silty, mixed, mesic Ultic Argixerolls) and Palouse silt loam (fine-silty, mixed, mesic pachic Ultic Haploxerolls), respectively. Water soluble phytotoxins from the surface crop residues were not found during the 3-year study. Furthermore, moving the crop residues from the seed row did not affect yields, but did alleviate the high crown node set which in turn reduced visual injury from soil active herbicides. Surface crop residues significantly improved water storage during the one season with a major runoff event, which increased grain yields and water use efficiencies, but had no effect when soil profiles were filled by spring. During the 3-year study,

winter wheat yields from plots direct drilled into surface cereal residues were equal to those from plots tilled and seeded conventionally. (Author's abstract)
W84-04992

KENTUCKY BLUEGRASS GROWTH AND WATER USE UNDER DIFFERENT SOIL COMPACTION AND IRRIGATION REGIMES,
Kansas State Univ., Manhattan. Dept. of Horticulture.
K. J. O'Neil, and R. N. Carrow.
Agronomy Journal, Vol. 74, No. 6, p 933-936, November-December, 1982. 3 Tab, 25 Ref.

Descriptors: *Turf grasses, *Water use efficiency, *Soil compaction, *Irrigation efficiency, Plant growth, Aeration porosity, Soil physical properties, Soil water, Water retention.

Soil compaction and efficient use of irrigation water are important concerns of turfgrass managers. This field study examined effects of soil compaction on growth and water utilization of a cool-season turfgrass species under different irrigation programs. A 2-year-old stand of Poa pratensis L., 'Baron,' on a fine, montmorillonitic mesic Aquic Arguidoll soil, was subjected to four treatments resulting from a factorial design with two levels of compaction (none and 30 passes per week with roller) and two levels of irrigation (set schedule of 3.8 cm water per week plus rainfall and 3.8 cm when tensiometer at 10 cm depth read -0.70 bar). Soil compaction had no effect on root weight or distribution. Visual quality, shoot density, verdure, and percent total cover were reduced by compaction while total nonstructural carbohydrates (TNC) were unaffected. In the surface 3 cm of soil, compaction increased bulk density and moisture retention but reduced aeration porosity at -0.1 bar from 18.1 to 12.5%. Irrigation treatment had no effect on any of the soil physical properties. Without affecting turf quality, water use with tensiometer was reduced by 28 and 48% on noncompacted and compacted areas, respectively, compared to set-schedule irrigated plots. Water use over a 9-day period in August indicated that the turf grown under the tensiometer scheduled regime was physiologically or anatomically adapted to use less water even when it was available. This adaptation was not due to differences in vegetative or root growth in this study. Compaction reduced water use by 20% over the 4 month study. During a 9-day period in August, compaction reduced water use by 3.5 to 11% for the tensiometer and set-scheduled treatments, respectively. This response appeared to be due primarily to altered moisture retention properties and reduced shoot growth. Thus, compacted and noncompacted sites should be irrigated on separate schedules. (Author's abstract)
W84-04993

EFFECT OF IRRIGATION AND ROW SPACING ON SOYBEAN WATER USE,
Agricultural Research Service, Morris, MN.
D. C. Reicosky, H. R. Rowse, W. K. Mason, and H. M. Taylor.
Agronomy Journal, Vol. 74, No. 6, p 958-964, November-December, 1982. 6 Fig, 5 Tab, 10 Ref.

Descriptors: *Irrigation effects, *Row spacing, *Soybean, *Water use efficiency, Crop yield, Soil water, Evapotranspiration, Soil water.

A better understanding of the soil-water plant spacing interactions as they affect water-use efficiency and crop yields requires the development of satisfactory methods for determining water use. The objective of this work was to determine the effect of 25- and 100-cm row spacings on crop water use under irrigated and nonirrigated soybeans (Glycine max (L.) Merr.) on a fine, silty, mixed (calcareous) mesic family of Typic Udorthents soil. Water use was evaluated by measuring evapotranspiration and soil water extraction. Evapotranspiration (ET) was measured using a portable chamber that utilized psychrometric techniques to determine changes in the water vapor density when the chamber enclosed the crop canopy and the soil surface. Soil water extraction (SWE) was calculated from changes in gravimetric water content during periods without rainfall and then corrected for the flow of water at the bottom of the root zone. Irrigation resulted in the expected higher water use rates on both row spacings. The row spacing effect early in the season was related to the leaf area index (LAI). Early in the season, the 25-cm irrigated treatment had a slighly higher ET than the 100-cm irrigated treatment. Later in the season, row spacing effects were not evident. The two methods employed for evaluating crop water use showed only fair agreement. (Author's abstract)
W84-04995

POTATO IRRIGATION REQUIREMENTS IN A HOT CLIMATE USING SPRINKLER AND DRIP METHODS,
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
J. Shalhevet, D. Shimshi, and T. Meir.
Agronomy Journal, Vol. 75, No. 1, p 13-16, January-February, 1983. 4 Fig, 2 Tab, 12 Ref.

Descriptors: *Potato, *Irrigation requirements, *Sprinkler irrigation, *Drip irrigation, *Israel, Evaporation, Irrigation efficiency, Arid climates, Crop yield, Water potential.

Potato (Solanum tuberosum L.) is a heat- and drought-sensitive crop, which in hot climates usually requires large water applications for optimum production. Irrigation water in Israel is both limiting in quantity and high in price; thus it is critical to know the water requirement of the crop, as well as how to improve irrigation efficiency. Field experiments were conducted in the Negev (arid) region of Israel on a Typic Camborthid soil to determine the water production functions of potatoes ('Desiree') under drip and sprinkler irrigation. Irrigation treatments were based on Class A pan evaporation. The linear production functions relating total yield in metric ton/ha to seasonal water application depth (W) in cm were, for sprinkler irrigation: $Y = -23.5 + 1.19 W$, and for drip irrigation: $Y = -12.8 + 1.14 W$. Similar total maximum yields were obtained with about 8% less water with the drip as with the sprinkler method (not statistically significant). A single production function for both methods described the yield of marketable tubers: $Y = -40.0 + 1.28 W$. These functions apply in the relative water application range (water applied over Class A pan evaporation) of 0.3 to 1.0, at which point the function reaches a plateau. Yield was reduced by 12% as soil water potential in the 0 to 0.6 m depth increment changed from -20 to -29 J/kg for sprinkler irrigation. Under drip irrigation the soil could dry to -40 J/kg without yield reduction, as long as the water supply was adequate. This was explained by the higher root concentration under drip than under sprinkler irrigation. (Author's abstract)
W84-04997

DROUGHT RESPONSE OF SORGHUM HYBRIDS UNDER A SPRINKLER IRRIGATION GRADIENT SYSTEM,
Arizona Univ., Tucson.
M. K. O'Neill, W. Hoffman, A. K. Dobrenz, and V. Marcarian.
Agronomy Journal, Vol. 75, No. 1, p 102-107, January-February, 1983. 5 Fig, 3 Tab, 23 Ref.

Descriptors: *Drought resistance, *Sorghum, *Irrigation gradient, Sprinkler irrigation, Arid climates, Hybrids, Water stress, Plant growth.

Reliable techniques for identification of drought-resistant germplasm are essential if new lines and hybrids are to be developed for arid and semiarid areas of the world. This experiment was designed to evaluate the irrigation gradient system as a mechanism for evaluating drought tolerance in sorghum (Sorghum bicolor (L.) Moench.) in the field. Fifty sorghum hybrids which were developed with A-lines 'CK-60' and 'Redlan' were planted perpendicular to the mainline of the sprinkler irrigation gradient system at Yuma, Ariz. in 1979 and 1980. The soil was a superstition sand (sandy, mixed, hyperthermic Typic Calciorthid) with an average available soil moisture of 3.6%. Characteristics including panicle rank, anthesis date, plant height, panicle and peduncle length, crown diameter, and plant weight were measured on plants of each hybrid grown in the high and low water areas of the gradient system. The distance from the line source to the last grain-producing panicle in the low water area of the gradient was also measured on each hybrid. Hybrids developed with CK-60 were able to produce seed-producing panicles in drier areas of the gradient compared to hybrids developed with Redlan. The average distance from the sprinkler line source was 14.4 m for CK-60 hybrids and 11.3 m for Redlan hybrids over both years. Days to anthesis, panicle and peduncle length of plants in the stressed area of the gradient may be potential indicators of drought resistance. The irrigation gradient system is a useful tool for evaluating drough resistance and the selection of parental lines over a wide range of available soil moisture conditions. (Author's abstract)
W84-04999

IRRIGATED CORN YIELD RESPONSE TO NITROGEN AND WATER,
Agricultural Research Service, Bushland, TX. Conservation and Production Lab.
H. V. Eck.
Agronomy Journal, Vol. 76, No. 3, p 421-428, May-June, 1984. 11 Fig, 3 Tab, 18 Ref.

Descriptors: *Corn, *Crop yield, *Irrigation requirements, *Nitrogen, Drought, Water stress, Irrigation timing, Fertilizers, Plant growth, High Plains.

Irrigated corn (Zea mays L.) is a relatively new crop on the Southern High Plains where the groundwater supply for irrigation is declining. Field studies were conducted to determine the plant nutrient needs for corn on a predominant soil of the area, the effects of timing and duration of drought stress periods, and the interacting effects of N levels and drought stress on N nutrition and production of corn. Fertilizer N rates ranged from 0 to 350 kg/ha. Irrigations were applied or deleted to allow the crop to be unstressed (I-1), stressed 2 weeks during late vegetative growth (I-2), stressed 2 weeks during early vegetative growth (I-2a), stressed 4 weeks during vegetative growth (I-3), stressed about 4 weeks during grain filling (I-4), and stressed about 2 weeks during grain filling (I-5). The soil was Pullman clay loam (fine, mixed, thermic Torrertic Paleustolls). Four-year average data (three with graded furrow irrigation, one in level borders) showed that 140 kg N/ha were sufficient for maximum yields. However, simultaneous experiments conducted on graded furrows and level borders showed that while 140 kg N/ha gave maximum yields on graded furrows, 210 kg N/ha were required in level borders. This comparison illustrates the possible fallacy in conducting fertilizer trials under one method of irrigation and extrapolating results to another. Two and 4 weeks of plant water stress during vegetative growth reduced yields of adequately fertilized (210 kg N/ha) corn 23 and 46%, respectively. Two-week stress periods during late (I-2) and early (I-2a) vegetative growth had similar effects on grain yields. Relationships between lengths of stress periods during grain filling and yield showed that yields were reduced 1.2% for each day stress was imposed during grain filling; however, as indicated by the r2 (0.31), there was considerable variation in the data. A N x water stress interation occurred on grain yields. Adequate N slightly increased corn grain yield under stress and greatly increased yield with full irrigation. Excessive N did not reduce yield even with severe water stress, thus, there would be no reason to reduce N rates to reduce water stress. As grain yields increased, the ratio of grain yield to N yield decreased until maximum yields were attained and then remained constant, indicating little luxury consumption of N. At maximum yield, typical grain yield/N yield ratios were about 52:1. At harvest soil NO3(-)-N levels showed that plants had removed most of the N applied at rates up to 140 kg/ha, but increasing amounts remained when N application rates were above 140 kg/ha. (Author's abstract)
W84-05000

OPTIMUM CROP WATER APPLICATION AS AFFECTED BY UNIFORMITY OF WATER INFILTRATION,
J. Letey, H. J. Vaux, Jr., and E. Feinerman.
Agronomy Journal, Vol. 76, No. 3, p 435-441, May-June, 1984. 9 Fig, 21 Ref. California State Water Resources Control Board contract 2-043-300-0.

Descriptors: *Infiltration rate, *Irrigation efficiency, *Corn, *Cotton, *Economic aspects, Crop yield, Uniformity, Costs.

Economic analyses of irrigated agriculture stress that yield levels which maximize profits can be attained with less water than maximum yields. A premise of such analyses is that irrigated soils have perfectly uniform rates of infiltration. A general method for evaluating the effects of nonuniform infiltration rates on optimal levels of water application is developed. Empirical analyses of the implications of non uniform infiltration rates on optimal levels of applied water, yields, and profits are reported for corn (Zea mays L.) and cotton (Gossypium hirsutum L.). The results are critically influenced by the nature of the water yield relationships postulated for these crops. For corn, where excessive water applications apparently have no effect on yield, nonuniform conditions reduce yield and profit. These outcomes can be offset by increasing water applications and optimal levels of applied water increase as the degree of uniformity declines. For cotton, nonuniformity leads to decreases in yields and profits that cannot be offset by increased water applications. This is attributable to the apparent sensitivity of cotton yields to excessive applications of water. For both crops, increases in the price of water provide little incentive to improve the uniformity of infiltration. The results demonstrate that conventional economic analyses which ignore infiltration uniformities, underestimate optimal levels of applied water, often substantially. (Author's abstract)
W84-05001

YIELD AND YIELD COMPONENTS OF 'BRAXTON' SOYBEANS AS INFLUENCED BY IRRIGATION AND INTRAROW SPACING,
Clemson Univ., SC. Dept. of Agronomy and Soils.
E. L. Ramseur, V. L. Quisenberry, S. U. Wallace, and J. H. Palmer.
Agronomy Journal, Vol. 76, No. 3, p 442-446, May-June, 1984. 1 Fig, 3 Tab, 33 Ref.

Descriptors: *Soybean, *Row spacing, *Crop yield, *Irrigation effects, Irrigation timing, Plant growth.

Soybean (Glycine max) yields in the Southeast historically have been lower than those obtained in the Midwest. Irrigation will increase soybean yields in the Southeast, but it is not known whether irrigation throughtout the growing season is more beneficial than irrigation begun at bloom. Yield and yield components of 'Braxton' soybeans, Maturity Group VII, were measured for differing irrigation regimes and intrarow spacings. Prior to the V3 growth stage, plots were thinned to achieve intrarow spacings of 61, 76, 102, 152, 305, and 457 mm in 1980 with spacings of 43 and 51 mm added in the 2nd year. Soil water regimes were full-season irrigation (FSI), irrigation beginning at bloom (BI), and no irrigation (NI). Seed yields for the 2 years, averaged over all spacings, were 3023, 2876, and 1322 kg/ha for the FSI, BI, and NI irrigation treatments, respectively. Yields were increased significantly with irrigation, but no significant difference in yield was measured between FSI and BI treatments. Yields among plant spacings were not significantly different for any irrigation treatment either year with the exception that the yield of the 457-mm spacing of the BI treatment was significantly reduced in 1981. Seed number was highly correlated with seed yield, whereas single seed weight was not significantly correlated with yield. Increases in seed number under the irrigation treatments were due to increases in both pod number and seed per pod. Seed growth rate was increased and effective filling period was decreased by irrigation. Intrarow spacings up to 457 mm had little influence on yield. Full-season irrigation gave no yield advantage over bloom irrigation. (Moore-IVI)
W84-05002

IRRIGATION SCHEDULING I: CROP AND SOIL PARAMETERS,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
D. K. Cassel.
Crops and Soils Magazine, Vol. 36, No. 5, p 16-20, February, 1984. 4 Fig, 1 Tab.

Descriptors: *Irrigation practices, *Soil properties, Water potentials, Plant growth, Crop yield, Root zone, Soil water, Infiltration, Water table, Runoff.

Soil, crop, and climatic parameters which must be considered in developing an effective and efficient irrigation scheduling method for a particular field include water balance, rooting depth, and available water capacity. As rain falls onto the soil it either runs off, ponds, or infiltrates the soil. As it infiltrates, it is stored at first in the layers of soil closest the surface. If enough rain falls, the water is lost to plant use through deep percolation. If prevented from infiltrating, the water will stand on the surface and evaporate or stand around the roots of the plants, causing damage due to lack of air. One of the keys to effective irrigation is to know precisely the rooting depth of the particular crop. Some soils have barriers that modify the potential rooting depth such as acid subsoils, rock strata, tillage pans, fragipans, clay pans, and caliche. Most agricultural soils drain to in situ field capacity within 1 to 3 days. An additional soil parameter that must be determined is soil bulk density which is the weight of oven dry soil per unit volume of soil. This value is needed to convert the wilting point and in situ field capacity water content data to inches of available water per inch of soil. Available water ranges from 0.02 inch/inch of soil for coarse sand to as much as 0.18 inch/inch of soil for silt loam. (Baker-IVI)
W84-05005

IRRIGATION SCHEDULING II: SIMPLE, LOW COST TECHNIQUES,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
D. K. Cassel.
Crops and Soils Magazine, Vol. 36, No. 6, p 15-18, March, 1984. 3 Fig. 3 Tab.

Descriptors: *Irrigation practices, *Water stress, Crop yield, Plant growth, Soil water, Irrigation requirements, Allowable depletion, Irrigation efficiency.

The idea of allowable soil water depletion is considered and several simple, relatively low cost irrigation scheduling techniques are proposed. Using these techniques, the irrigator can insure that the crop is not subjected to severe water shortages or that excessive irrigation water is not used. A primary consideration is how dry the crop rooting zone should be allowed to get before irrigation water is needed. Allowable depletion is the percentage of the available water stored in the crop root zone that the crop can use without undergoing severe moisture stress. After establishing the rooting depth of a particular crop on a particular soil, measure the available water capacity in the root zone, and decide to allow the crop to deplete only 50% of the available water. Water applications can then be scheduled using soil measurements, plant measurements or climatological measurements. Feeling the soil at various times and locations throughout the field will give a general knowledge of the amount of available water in the soil. Gravimetric soil sampling requires the collection of soil samples from the root zone at representative locations in the field. A tensiometer can also be used which does not measure directly the amount of water in the soil, but measures soil moisture tension or suction which is the energy that must be exerted by a plant to extract water from the soil. Electrical resistance blocks, commonly called gypsum blocks or moisture blocks, produce a calibration curve showing the relationship between the electrical resistance and soil water content, thus allowing the operator to determine when to irrigate. Moisture blocks work well in fine- and medium-textured soils but are not recommended for sandy soils. (Baker-IVI)
W84-05006

IRRIGATION SCHEDULING III: SOPHISTICATED TECHNIQUES,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
D. K. Cassel.
Crops and Soils Magazine, Vol. 36, No. 7, p 20-23, April-May, 1984. 3 Fig, 1 Tab.

Descriptors: *Irrigation practices, *Soil water, *Measuring instruments, Infrared thermometer, Neutron meter, Plant growth, Moisture stress, Crop yield.

Sophisticated irrigation scheduling techniques discussed include the neutron meter method, the checkbook method, and use of the infrared thermometer. The neutron moisture meter measures soil water content without collecting individual soil samples. Once the neutron access tubes are installed, the irrrigator can repeatedly and reliably determine the soil water content at the same place. The checkbook scheduling method is similar to transfering money into and out of a bank account. Water added to the soil by rainfall or sprinkler irrigation can be measured with rain gauges placed in the field. Withdrawals of water from the crop root zone are through drainage and evapotranspiration. Where the water deposit and withdrawal information is available for a given day, the checkbook can be balanced. The soil water content computed by this method must be periodically (every 2 to 4 weeks) checked against the actual soil water content and the value adjusted. An infrared thermometer is used to measure the intensity of the infrared radiation emitted by an object. When plenty of water is present, healthy plants transpire water at a rate fast enough to satisfy the evaporative power of the incoming solar radiation. In arid or semi-arid regions, the plant undergoes moisture stress when the temperature of the plant leaves or plant canopy is higher than the air temperature. Portability of an infrared thermometer makes it a convenient tool and it costs between $1,000 and $3,500 at present. (Baker-IVI)
W84-05007

WATER STRESS STATUS IN GUAYULE AS MEASURED BY RELATIVE LEAF WATER CONTENT,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
W. L. Ehrler, and F. S. Nakayama.
Crop Science, Vol. 24, No. 1, p 61-66, January-February, 1984. 7 Fig, 1 Tab, 7 Ref.

Descriptors: *Leaf water content, *Water stress, *Guayule, Soil water deficit, Irrigation effects, Irrigation requirements.

The relative leaf water content (RLWC), defined as the ratio of leaf water content at sampling to that at full turgor, was observed to be a sensitive indicator of soil water deficits for two cultivars of guayule (Parthenium argentatum Gray) in an experiment at Phoenix, Ariz. A year's measurements showed highly significant correlation coefficient values for the linear regression of RLWC on the amount of water in the soil (mm water/170-cm depth of soil). The r values ranged from 0.93 in the dry treatment to 0.78 in the wet treatment of cv. 593, which consistently depleted the soil moisture to lower values than 11591. The RLWC decreased to extremely low values, 30 to 40%, but irrigation restored them to about 75% overnight, accompanied by a gain in leaf area of as much as 30%. The RLWC technique does not require elaborate instrumentation or procedure and may be useful as a guide to irrigation scheduling of guayule. (Author's abstract)
W84-05009

DRIP WATERING SYSTEMS FOR GREAT PLAINS WINDBREAKS,

Soil Conservation Service, Lincoln, NE.
K. A. Ticknor, and D. L. Hintz.
Journal of Soil and Water Conservation, Vol. 39, No. 2, p 113-114, March-April, 1984, 2 Fig.

Descriptors: *Drip irrigation, *Windbreaks, Shelterbelts, Great Plains, Trees, Irrigation, Irrigation practices, Water demand, Nebraska, Kansas.

Use of drip watering systems has boomed because the systems provide a simple, efficient, and low-cost means of watering trees and shrubs, particularly useful for windbreaks in the Great Plains. A 60% survival rate is typical for windbreak trees in the Great Plains area with a 30% or less being common for some species. Use of the drip watering systems can improve that survival rate to 90%. Such a system consists of lateral lines, usually one-half-inch polyethylene pipe, placed in each tree row and fitted with a pressure-compensating emitter at each tree. A field review of drip watering systems was made to evaluate six years of their use in Nebraska and Kansas. Variable conditions of soils, weather, site preparation, and weed control have had little effect on survival when supplemental water is supplied by drip watering systems. Trees and shrubs should be watered at least once per week during the first year after planting. Four to 10 gallons of water should be applied per plant per watering. Site preparation and weed control had more effect on growth than watering. (Baker-IVI)
W84-05055

RESPONSE OF SQUASH TO IRRIGATION, NITROGEN FERTILIZATION, AND TILLAGE SYSTEMS,
Georgia Coastal Plain Experiment Station, Tifton.
For primary bibliographic entry see Field 2I.
W84-05062

EFFECTS OF RAINFALL AND IRRIGATION MANAGEMENT ON CITRUS JUICE QUALITY IN TEXAS,
Agricultural Research Service, Weslaco, TX.
For primary bibliographic entry see Field 2I.
W84-05064

EFFECT OF REDUCED WATER SUPPLY ON PEACH TREE GROWTH AND YIELDS,
Victoria Dept. of Agriculture, Tatura (Australia). Irrigation Research Inst.
P. D. Mitchell, and D. J. Chalmers.
Journal of the American Society of Horticultural Sciences, Vol. 107, No. 5, p 853-856, 1982. 2 Fig, 3 Tab, 10 Ref.

Descriptors: *Water conservation, *Peaches, *Irrigation efficiency, Trickle irrigation, Evaporation, Plant growth, Crop yield.

A range of irrigation levels was compared in specific periods of fruit development to determine their suitability for control of tree vigor and yields in ultra-dense orchards of peach (Prunus persica L. Batsch) trees. Where trees in the 3rd leaf were trickle-irrigated with 4 levels (100, 50, 25, and 12.5%) of replacement of Eps (evaporation over the planting square) during the period of rapid vegetative growth, both frame and fruit growth declined as irrigation quantity decreased. In the following period of maximum fruit growth, 130% of Eps replacement increased vegetative growth but not fruit growth compared to 100% Eps. The fruit, however, grew faster in this period on those trees which had received low levels of Eps replacement in the earlier period of maximum vegetative growth. The net result was similar final fruit size and yield between treatments, combined with control of vegetative growth at the lower levels of Eps. A large saving in irrigation water was obtained at the lower levels of replacement of Eps. (Author's abstract)
W84-05066

SOIL CATION AND WATER DISTRIBUTION AS AFFECTED BY NH4NO3 APPLIED THROUGH A DRIP IRRIGATION SYSTEM,
Agricultural Research Service, Byron, GA. Southeastern Fruit and Tree Nut Research Lab.
J. H. Edwards, R. R. Bruce, B. D. Horton, J. L. Chesness, and E. J. Wehunt.
Journal of the American Society of Horticultural Science, Vol. 107, No. 6, p 1142-1148, 1982. 6 Fig, 6 Tab, 19 Ref.

Descriptors: *Peaches, *Drip irrigation, *Crop yield, *Fertilizers, *Aluminum, Ammonium nitrate, Plant growth, Soil chemistry, Hydrogen ion concentration, Calcium, Magnesium.

Drip irrigation has significantly increased both tree growth and marketable fruit yield where rainfall is lacking at critical times during the production cycle, as frequently occurs in the southeastern U.S. Drip irrigation can also be used to supply water-soluble nutrients, but this practice may have an effect on growth and fruit yield. 'Redglobe' peaches were grown under drip irrigation to compare applications of NH4NO3 through the irrigation system with broadcast applications. Soil pH, where NH4NO3 was applied through the irrigation system, decreased in the top 30 cm from 6.2 to 3.7 pH in the zone wetted by emitters that had been in place for 2 years, and from 6.2 to 4.5 pH in the zone where emitters had been in place for 6 months. Aluminum concentration in wetted zones increased from 0.01 to 1.45 meq/100 g of soil after 2 years and from 0.02 to 0.73 meq/100 g of soil after 6 months of NH4NO3 application through drip irrigation. Soil Ca and Mg concentrations were reduced in both wetted zones, but the greatest decrease occurred in the 2-year emitter site. The application of acid forming NH4NO3 fertilizer to a relatively small soil volume decreased pH and increased Al-solubility. These soil chemical characteristics reduce root density at the emitter and restrict the absorption of water, which had a large adverse effect on fruit yields. (Moore-IVI)
W84-05067

EFFECTS OF IRRIGATION PRACTICES ON VINE GROWTH, YIELD, AND QUALITY OF MUSKMELONS,
Arizona Univ., Tucson. Dept. of Plant Sciences.
W. D. Pew, and B. R. Gardner.
Journal of the American Society of Horticultural Science, Vol. 108, No. 1, p 134-137, 1983. 6 Tab, 8 Ref.

Descriptors: *Irrigation practices, *Plant growth, *Muskmelons, *Crop yield, Fruit crops, Irrigation, Soil water.

Irrigation experiments were conducted over 4 seasons in cooperation with a commercial muskmelon grower. In each year of the study wet treatments resulted in lower yields and smaller fruit. Plants receiving a prethinning irrigation were visibly smaller. The appearance of small tops on the plants in the prethinning irrigation treatment plots at thinning, coupled with the unnatural appearance of the root system from the mature plants, indicated a restricted, atypical plant- and root-growth pattern. This could have resulted from low oxygen levels. More fruits were culled due to decay where more irrigations were used. Decay was related to wetness of the tissue in contact with the soil. Some significant effects of treatment were found associated with vein tracts, flesh color, flesh firmness, and ratio of flesh to cavity, but these were not consistent from year to year. (Baker-IVI)
W84-05069

CONSUMPTIVE WATER USE OF IRRIGATED PECANS,
Texas A and M Research and Extension Center, El Paso.
S. Miyamoto.
Journal of the American Society of Horticultural Science, Vol. 108, No. 5, p 676-681, 1983. 4 Fig, 5 Tab, 10 Ref.

Descriptors: *Consumptive use, *Crop yield, *Pecans, *Irrigation requirements, Trees, Water demand, Water stress, Irrigation practices.

Water use data obtained from 7 commercial pecan orchards in the El Paso-Las Cruces valleys is presented. Such data are needed for planning and scheduling irrigation. Test trees (8 to 35 yr old) were surface-irrigated. The trees were of various size trunks (13-35 cm in trunk diameter) and planting densities (60-120 trees/ha). A neutron moisture probe was used to evaluate soil water depletion. Soil water depletion below a depth of 100 cm was minimal and independent of the horizontal distance from tree trunks except in young trees. Consumptive water use was highly dependent on tree size and planting density. Close-spaced, full-grown trees used 100 to 130 cm per season. An empirical equation was developed, based on these field data, for computing crop coefficients and consumptive use from trunk diameters, planting densities, and weather data. These equations are useful for estimating consumptive use of orchards with different tree sizes and populations. Estimates can be improved if a practical means of measuring live-leaf areas of trees becomes available. (Baker-IVI)
W84-05071

UTILIZATION OF RECYCLED IRRIGATION WATER ON MARIGOLDS FERTILIZED WITH OSMOCOTE AND CONSTANT LIQUID FERTILIZATION,
California State Univ., Fresno.
G. M. Koch, and E. J. Holcomb.
Journal of the American Society of Horticultural Science, Vol. 108, No. 5, p 815-819, 1983. 2 Fig, 6 Tab, 11 Ref.

Descriptors: *Irrigation practices, *Water reuse, *Fertilizers, Plant growth, Marigolds, Nitrogen, Phosphorus, Potassium, Trickle tube irrigation, Capillary mat irrigation, Water conservation.

In order to evaluate the use of leachate from Osmocote controlled-release fertilizer (CRF) and constant liquid fertilizer (CLF)as a partial source of irrigation water for greenhouse plants, marigolds were grown with either trickle tube or capillary mat irrigation. Within each fertilizer regime, half of the pots were irrigated and the leachate collected daily for reuse, while the other half pots were irrigated and the leachate discarded. Nitrate and potassium ions did not accumulate significantly in the irrigation reservoir when the leachate from Osmocote or CLF was used. No accumulation of salts occurred whether marigolds were irrigated by capillary mat or trickle tube. With one exception, plants fertilized with Osmocote at the recommended rate or twice this rate produced plants equal to or better than CLF at 100 ppm N. Except for recycled CLF, macronutrient content of plant tissues was within acceptable ranges. Fertilizer treatments did not affect the number of days to flower. The combination of Osmocote fertilization and capillary mat irrigation was more effective in producing high-quality plants than Osmocote fertilization and trickle-tube irrigation. Tap-water utilization was reduced substantially by using recycled water. (Baker-IVI)
W84-05072

YIELD COMPONENTS AND POD QUALITY OF SNAP BEANS GROWN UNDER DIFFERENTIAL IRRIGATION,
Oregon State Univ., Corvallis. Dept. of Horticulture.
A. R. Bonanno, and H. J. Mack.
Journal of the American of Society of Horticultural Science, Vol. 108, No. 5, p 832-836, 1983. 3 Fig, 4 Tab, 22 Ref.

Descriptors: *Beans, *Irrigation effects, *Crop yield, Soil water potential, Water stress.

Field experiments were conducted to evaluate the effects of differential irrigation treatments on the yield and pod quality of 'Oregon 1604' and 'Galamor' snap beans (Phaseolus vulgaris L.) in 1981 and 1982. Treatments in which various levels of positive canopy minus air temperature differences (stress-degree-days (SDD)) accumulated between irrigations were evaluated along with irrigation at 4 growth stages, a dry treatment which received only one irrigation to establish plants, and a control treatment irrigated at -0.06 MPa soil water potential (SWP). In both seasons, yield was related

strongly to the average soil water potential from planting to harvest. Yields in 1982 were at least 5 MT/ha greater at a given average soil water potential than in 1981. Yields of 'Oregon 1604' and 'Galamor' were similar under adequate irrigation, but under greatest water stress, yield of 'Oregon 1604' was higher than for 'Galamor'. Pod number was reduced only in the dry treatment. Percentage of set pods, pod length, and number of seeds per pod were all reduced by low irrigation, while fiber content of pods and weight per seed were increased by low irrigation. (Author's abstract)
W84-05073

WATER RELATIONS AND GROWTH OF SNAP BEANS AS INFLUENCED BY DIFFERENTIAL IRRIGATION,
Oregon State Univ., Corvallis. Dept. of Horticulture.
A. R. Bonanno, and H. J. Mack.
Journal of the American Society of Horticultural Science, Vol. 108, No. 5, p 837-844, 1983. 10 Fig, 5 Tab, 31 Ref.

Descriptors: *Beans, *Irrigation effects, *Plant growth, *Water potential, Soil water, Water stress, Turgor, Transpiration, Evaporation, Stomatal closure.

Two field experiments were conducted to evaluate the effects of differential irrigation on plant growth, development, and water status of 2 snap bean cultivars, 'Oregon 1604' and 'Galamor' (Phaseolus vulgaris L.). Plants were grown at various irrigation levels ranging from a well-watered control to a dry treatment which received only one irrigation to establish plants. Measurements on plants sampled weekly at 6 times during the growing season showed that total plant dry weight, total leaf dry weight, total leaf area, average area per leaf, and number of leaves per plant were reduced by water deficits in both cultivars. Also, for both cultivars, total leaf area per plant was reduced more by a decrease in area per leaf than by a reduction in leaf number. Specific dry leaf weight was higher in the drier treatments. During each year, a significant difference between treatments occurred earlier in the season for total leaf area per plant than for total plant weight. At predawn, leaf water potential (Psi) always was more negative in the dry treatment than in the control. Early in the season, there was no significant difference in midday Psi between the control and dry treatment. Later, as soil water became limiting, the dry treatment had a more negative Psi than the control. Near the end of the season, after the dry treatment had been subjected to a long period of water stress, midday Psi was more negative in the control than in the dry treatment. Although some osmotic adjustment occurred in the dry treatment, leaf turgor potential (Psi p) was generally lower than in the control throughout the day. As Psi decreased from early morning through midday, transpiration rates increased due to an increase in evaporative demand on the leaves. Leaf diffusive resistance also increased with decreasing Psi but a 'threshold value' for stomatal closure was not demonstrated. (Author's abstract)
W84-05074

WATER USE AND CONSERVATION IN THE SOVIET UNION (JOKIEN MONINAISKAYTOSTA JA SUOJELUSTA NEUVOSTOLIITOSSA),
Turku Univ. (Finland). Institutum Geographicum. H. Mansikkaniemi.
Terra, Vol. 95, No. 4, p 227-231, 1983. 2 Fig.

Descriptors: *USSR, *Water conservation, *Drainage, Planning, Irrigation, Water pollution control.

The activities of the water planning boards in the Soviet Union are extremely extensive. There are two million people employed in these operations and of these 70000 are engaged in actual planning work. Their tasks include designing irrigation systems in dry areas and also drainage systems in wet regions. The present aim is to drain 1 million hectares per year and also irrigate a corresponding area. The Soviet authorities have noted that pollution of many rivers has risen to a worrying level. To prevent the situation deteriorating further a start had recently been made a large-scale program of care and protection embracing all those rivers where the main channel is more than 200 km long or the precipitation area is more than 2000 sq km. (Author's abstract)
W84-05081

DRIP IRRIGATION OF COTTON WITH TREATED MUNICIPAL EFFLUENTS: I. YIELD RESPONSE,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 5D.
W84-05115

DRIP IRRIGATION OF COTTON WITH TREATED MUNICIPAL EFFLUENTS: II. NUTRIENT AVAILABILITY IN SOIL,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 5D.
W84-05116

IMPACT OF WATER CUTBACK ON SUGARCANE PRODUCTION IN THE FLORIDA EVERGLADES,
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
S. F. Shih.
Water Resources Bulletin, Vol. 20, No. 2, p 187-191, April, 1984. 5 Tab, 10 Ref.

Descriptors: *Sugarcane, *Everglades, *Florida, *Water cutback, Water conservation, Water table, Drought, Crop yield, Water demand.

Sugarcane (Saccharum spp.) was planted in six lysimeters containing Pahokee muck (Lithic Medisaprist) where water tables were maintained at 30, 60, and 90 cm depths. The main objective was to study the impact of a 40% water cutback (108 mm) on sugarcane production during the period near the end of the dry season (i.e., May). The water cutback treatment was simulated through manipulation of water table depth. Due to the high available water capacity of the muck soil and selection of a sugarcane cultivar 'CP63-588' (which has a high tolerance of water table fluctuations), the sugarcane growth, and the yields of sugarcane biomass and sugar were not significantly different as a result of the treatments with and without 40% water cutback during a period of two months. This result is in good agreement with the 1981 cane yield in the Everglades Agricultural Area where a 35% water cutback was imposed during the 1981 drought. (Author's abstract)
W84-05157

GEOSTATISTICAL APPROACH TO THE TRICKLE IRRIGATION DESIGN IN A HETEROGENEOUS SOIL. 2. A FIELD TEST,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
D. Russo.
Water Resources Research, Vol. 20, No. 5, p 543-552, May, 1984. 8 Fig, 4 Tab, 13 Ref.

Descriptors: *Trickle irrigation, *Crop yield, Irrigation practices, Irrigation, Water supply development, Soil properties.

The spatial variability of the measured midway soil water pressure head as well as the total fruit yield of bell pepper obtained under uniform and nonuniform spacing between trickle irrigation emitters throughout the field are analyzed. In a heterogeneous field in which the soil water properties vary under a deterministic uniform trickle irrigation system, the midway soil-water pressure head (h-c), and the yield of a crop also differ from place to place. The experimental plan was tested to determine whether the spatial variability of the response of a heterogeneous field could be reduced by using a spatially variable trickle irrigation system. The reduction in the spatial variability of the field response was expected to reduce the spatial variability in the crop yield Y, which in turn may increase the average over the field crop yield. Twenty-five plots were established on a 30 sq m grid. Half of each plot was equipped with a standard trickle irrigation system with constant spacing between emitters of d = 50 cm. The other half was equipped with a trickle irrigation system for which the spacing between the emitters was selected by using the pertinent hydraulic properties according to the procedure of Bresler (Irrigation Science, Vol. 3, p 3-17, 1978). Use of a spatially variable d relative to the use of a uniform d did not change the seasonal behavior of h-c, but reduced the spatial variability, increased the integral scale, but increased the average fruit yield by only 1.9%. When emitters were properly spaced it was not the water but other factors that most influenced yield. (Baker-IVI)
W84-05328

ECONOMIC RESULTS OF SIMULATED CHANGES IN PAKISTAN'S IRRIGATION SYSTEM,
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
S. H. Johnson, III, and J. O. Reuss.
Water Resources Research, Vol. 20, No. 5, p 629-632, May, 1984. 1 Fig, 6 Tab, 14 Ref.

Descriptors: *Water resources development, *Irrigation practices, *Water management, Pakistan, Model studies, Punjab, Crop yield, Indus River Basin.

An integrative simulation model is used to simulate alternative water management systems for the Punjab, the largest state in Pakistan. Results from the model indicate that current canal closure schedules severely restrict economic returns from possible cropping systems. Closure during February, or in April after wheat harvest, increases possible returns by $20-$30 per hectare. Demand systems, while strongly advocated by numerous consultants, are not as economically productive as are present continuous flow systems. Only after per hectare water allocation is increased by more than 1.5 times do demand systems provide a higher per hectare economic return. A more viable alternative is continued use of the present system, supplemented by private tube wells operated on a demand basis. As more than 150,000 of these are already installed and in operation in the Punjab, capital investment is shifted from the public to the private sector. Initial results from the simulation model using base constant flow plus 5 ha cm per week of demand flow from private tube wells indicate that economic returns per hectare are greater than for the same quantity of water provided by constant flow or demand flow alone. Application efficiency is higher than constant flow and only marginally less than for a pure demand system. With more than 8 million ha of irrigated land in the Punjab, losses from canal closure during December could exceed $200 million per year. (Baker-IVI)
W84-05335

WATER-MANAGEMENT POTENTIAL OF RUNOFF-CONTROLLED IRRIGATION AND SOME BASIC SUGGESTIONS FOR IMPLEMENTING THE PROCEDURE (WASSERWIRTSCHAFTLICHE POTENZEN DER ABFLUSSGESTEUERTEN BEWASSERUNG UND EINIGE GRUNDAUFGABEN ZUR EINFUHRUNG DES VERFAHRENS),
Institut fuer Wasserwirtschaft, Berlin (German D.R.).
R. Meissner.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 167-171, May, 1983. 1 Fig, 6 Tab, 4 Ref.

Descriptors: *Water management, *Irrigation efficiency, *Irrigation, Irrigation-return flow, Irrigation programs, Irrigation practices, Irrigation water, Water demand.

An alternative to conventional methods of covering the water demand for overhead irrigation during periods of low availability is runoff-controlled irrigation (RCI), the main goal of which is to shift irrigation times into periods in which there

is no water shortage. In this way the storage capacity of the ground is utilized, and irrigation-water demand is reduced by 25% for a mean application of 100 mm during the critical July-October period. Experiments in the procedure were performed at three locations in the German Democratic Republic between 1973 and 1980. For location Lo1, RCI (irrigation only when adequate runoff as measured by lysimeter were available) resulted in the application of 60 mm less water during hydrological shortage periods than irrigation controlled by climatic water balance (CWI) and 47 mm less than irrigation controlled by a combination of runoff supply and crop need (RNI). Mean crop yield was almost identical for all three irrigation variants. During hydrological shortage periods at location D2, RCI used 86 mm less water than irrigation according to government guidelines (GI) and 72 mm less than RNI. For the period 1974-1980 at D2, RCI, GI and CWI, and RNI resulted in absolute crop-yield increases of 32, 38 and 48%, respectively. At location V1 in 1980, RCI according to measurements at a specific lysimeter, RCI with water reduction during shortages, and GI were compared. Under mostly normal hydrological conditions, similar crop yields were produced and almost the same amounts of irrigation water were needed. An economic analysis of results at D2 showed that profit made from higher crop yields made possible by the greater amount of sprinkling allowed by GI were not enough to offset higher production and water-storage costs, the latter of which were absent for RCI. It is planned to incorporate the principles of RCI into GI, and a concept for this is described using a computer to provide feedback information to farmers via the local water management district. (Gish-IVI)
W85-04800

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

EFFECT OF CUTTING ON THE GROWTH AND RECESSION OF THE FRESHWATER MACROPHYTE RANUNCULUS PENICILLATUS (DUMORT.) BAB. VAR. CALCAREUS (R. W. BUTCHER),
C. D. K. COOK,
Reading Univ. (England). Dept. of Zoology.
S. F. Ham, J. F. Wright, and A. D. Berrie.
Journal of Environmental Management, Vol. 15, No. 3, p 263-271, October, 1982. 1 Fig, 3 Tab, 9 Ref.

Descriptors: *Cutting management, *Growth, *Growth rates, *Macrophytes, *Ranunculus, Rivers, Flood prevention, Fishery management, River Kennet, Littlecote, River Lambourn, Bagnor.

Aquatic macrophytes grow profusely in English chalk streams, where they usually have high levels of nutrients and a stable flow regime. During the summer, the growth can seriously impede the flow of water and cause flooding of neighboring land. Two sites, one on the River Kennet at Littlecote and the other on the River Lambourn at Bagnor, were used to examine the effect of bar cutting on the growth and recession of the dominant macrophyte, Ranunculus penicillatus var. calcareus. At the Littlecote site, uncut Ranunculus was flowering by mid-May and started to wash out in July. Plants cut on 30 April flowered by early June, but did not begin to wash out until September. Ranunculus cut on 5 June regrew, but was unable to flower, and produced large areas of vegetative growth which led to increased cover in the following winter. Cutting in September was effective in controlling cover of Ranunculus during the winter, but was only applied to areas where Ranunculus was being washed out naturally. At the Bagnor site, cutting on 30 May delayed the time of wash out of Ranunculus, but did not increase its cover during the winter. It was concluded that, if Ranunculus was left uncut, it would begin to wash out naturally soon after flowering. A cut before flowering did not control growth and could increase the amount of Ranunculus during the following winter. Cutting at the time of flowering was the most effective way to control the summer growth. (Murphy-IVI)
W84-04818

THEORETICAL PROPERTIES OF THE OPTIMAL RELEASE FOR A MULTI-PURPOSE RESERVOIR WITH CORRELATED INFLOWS,
Technical Univ. of Lisbon (Portugal). Dept. of Civil Engineering.
L. V. Tavares.
Journal of Hydrology, Vol. 58, No. 3/4, p 237-250, September, 1982. 26 Ref.

Descriptors: *Multipurpose reservoirs, *Model studies, Stochastic process, Reservoirs, Stochastic hydrology, Dynamic programming, Systems analysis.

A general model is proposed to study a multipurpose reservoir with auto-correlated inflows and a stochastic dynamic programming formulation is used to derive three theorems concerning the reduction of the dimension of the state space, the concavity of the objective function, and the functional form of the optimal releases policy with a time varying utility function. The model assumes significant persistence for the inflow time-series as well as a time-varying utility function. The stochastic dynamic programming formulation is used not to compute numerical solutions but rather to deduce the following analytical conclusions: the usual description of the state of the system by a two-component vector can be synthesized by a scalar without any loss of information; the functional form of the optimal releases policy is deduced assuming that the generated marginal utility does not depend on the release obtaining a generalization of the linear decision rule. For this last case, the computational work required to determine the optimal solution can be greatly reduced by making use of the previous conclusions because the optimal parameter to be determined at each stage only depends on the state of the system through the expectation of the inflow during next time unit. It is proved that if the marginal generated utility depends on the release, then its optimal value is a non-linear function of the existing storage and hence neither the linear decision rule nor the delta-rule is the best operations policy. An algorithm is proposed to determine the optimal releases making use of the various conclusions reached. (Baker-IVI)
W84-04849

ECONOMIC FEASIBILITY OF FLOOD CONTROL IMPROVEMENTS,
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W84-04954

OPTIMAL OPERATION OF MULTIPLE RESERVOIR SYSTEMS,
Texas Dept. of Water Resources, Austin. Engineering and Environmental Systems Section.
Q. W. Martin.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 58-74, January, 1983. 3 Fig, 25 Ref.

Descriptors: *Reservoirs, *Operating policies, Management, Water resources development, Powerplants, Planning, Decision making.

A computational procedure has been developed to solve the problem of obtaining the most beneficial long-term operation of a surface water resources system so as to meet the purposes of water supply, stream flow maintenance, and hydroelectric power generation, while satisfying operational constraints for the system. The procedure is based upon the representation of the steady-state operation of a general surface water system of reservoirs, stream junctions, natural waterways, pipelines, and canals as a network flow problem. The incorporation of hydroelectric power generation benefits are undertaken by solving successive minimum cost network flow problems, where flow bounds and unit costs are modified between successive iterations to reflect first-order changes in hydroelectric power generation with flow release rates and reservoir storage. The procedure is shown to converge to a stationary or local optimum solution. Convergence to the global optimum could not be guaranteed since the benefit function is not convex. The algorithm, as coded in the AL-V and SIM-V programs, was applied to a large scale system of 27 reservoirs on the Arkansas, White, and Red Rivers. The derived system operating policy computed a potential increase of about 8% in the firm power production of the system over that determined in a previous study. (Baker-IVI)
W84-04956

INTEGRATED DEVELOPMENT OF A LARGE RIVER: THE RHONE; A. GENERAL DESIGN AND EFFECT ON FLOODS AND SUBSURFACE WATER LAYERS (L'AMENAGEMENT INTEGRE D'UN GRAND FLEUVE: LE RHONE; A. CONCEPTION GENERALE ET EFFETS SUR LES CRUES ET LES NAPPES PHREATIQUES),
Compagnie Nationale du Rhone, Lyon (France).
For primary bibliographic entry see Field 8A.
W84-05019

WATER USE AND CONSERVATION IN THE SOVIET UNION (JOKIEN MONINAISKAYTOSTA JA SUOJELUSTA NEUVOSTOLIITOSSA),
Turku Univ. (Finland). Institutum Geographicum.
For primary bibliographic entry see Field 3F.
W84-05081

HADDINGTON FLOOD WARNING SCHEME,
Forth River Purification Board, Edinburgh (Scotland).
R. J. Sargent.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 2, p 108-118, April, 1984. 5 Fig.

Descriptors: *Flood forecasting, *Automation, *Haddington, *Scotland, Microprocessors, Computers, Data acquisition, Decision making, Catchment areas, Flood warning.

The flood problem at Haddington in the Tyne catchment is used to provide an example of the use of automatic data collection and control. The flood water is generated on the steep slopes of the Lammermuir Hills, which lie to the south of the town and are drained by two main tributaries, the Birn's Water to the west and the Gifford to the east. Microprocessor technology provides a flood warning system where 24 hr manning would not otherwise be possible. The microprocessor automates both the collection of field data and the consequent operational decision-making. Remote stations are regularly interrogated by radio and quality control operations are then performed on the data received. While some faults were expected, the equipment has functioned nearly faultlessly with the few failures being the result of radio links. Cost details of the scheme are provided. (Baker-IVI)
W84-05136

MUNICIPALITIES ACT TO SUPPLEMENT DWINDLING GROUNDWATER SUPPLIES,
For primary bibliographic entry see Field 5F.
W84-05150

DEVELOPMENT OF THE WESTERN TIGRIS-BASIN IN TURKEY (AUSBAU DES WESTLICHEN TIGRIS-BECKENS IN DER TURKEI),
9 Eylul Univ., Izmir (Turkey). Dept. of Engineering and Architecture.
U. Ozis.
Wasserwirtschaft, Vol. 73, No. 4, p 109-112, April, 1983. 2 Fig, 6 Tab, 11 Ref.

Descriptors: *Tigris basin, *Turkey, *Water resources development, *Water harvesting, Regional

development, Hydroelectric power, Irrigation programs.

In the western Tigris basin Turkey is developing projects to irrigate 0.6 million hectares and to generate 8 billion KWh/a electricity with 2200 MW installed capacity, at a cost of 15 billion DM. The project includes 4 dams on the main stream, with several installations on branches of the river. The comprehensive project consists of several inherent projects which include the Kralkizi-Dicle, Silvan, Batman, Garzan, Ilisu and the Cizre projects, approximately 18 in all. The majority of the projects will occur upstream while a few major projects are in the lower Tigris. (Murphy-IVI)
W84-05237

TINAJONES PROJECT PART II (DAS TINAJONES-PROJEKT TEIL II),
Salzgitter A.G. (Germany, F.R.).
For primary bibliographic entry see Field 8A.
W84-05254

4B. Groundwater Management

GROUNDWATER STATE OF THE ART: IS IT ADEQUATE,
G. Goldstein.
Civil Engineering, Vol. 54, No. 4, p 68-72, April, 1984. 5 Fig.

Descriptors: *Groundwater management, *Water pollution control, Education, Training, Path of pollutants, Prevention, Legislation, Monitoring, Model studies.

Graduate level training must be increased in the area of groundwater management. The focus of groundwater education must take into account the rapid changes taking place in the field. Many complex problems which in earlier years would have been handled by a civil engineer or geologist now require the special knowledge of hydrogeologists and specialists in mathematical modeling, organic chemistry, geophysics, and microbiology. More research is needed on transport of contaminants in fractured rock and fractured silt and clay, the migration of toxic liquids that sink because of their high density, chemical and biochemical reactions of organic compounds in groundwater, epidemiology, contaminant migration and flow systems, and models. Preventive measures which should be taken to protect groundwater from future pollutants are listed. (Baker-IVI)
W84-04924

INVESTIGATIONS FOR ARTIFICIAL RECHARGE OF THE TRIASSIC SANDSTONES AQUIFER NEAR STOURBRIDGE, UK,
Severn-Trent Water Authority (England).
H. H. Jones.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 1, p 9-27, February, 1983. 5 Fig, 1 Tab, 20 Ref.

Descriptors: *Groundwater recharge, *Artificial recharge, *Stourbridge, *England, Water resources development, Reservoirs, Aquifers, Water resources development, Conjunctive use.

The demand for water resources in the Midlands of England is expected to increase, but at a lower rate than previously anticipated. The science and engineering of borehold recharge is discussed along with the current standards which are being adopted for the proposed recharge plant at Stourbridge in the West Midlands. The conventional method of obtaining public supplies from the Triassic Sandstones is to pump water directly from boreholes into service reservoirs. The construction of new boreholes will be limited to areas where there is adequate natural recharge, where pollutants such as nitrates and chlorides are unlikely to exceed standards for water supplies, and where the boreholes are sufficiently close to the location of demands for the total cost, including pipelines, to remain economic. Conjunctive use and artificial recharge using boreholes may enhance resources in the Midlands. Observation boreholes have now been constructed at twelve sites to monitor conditions in the aquifer. At five sites the boreholes are either constructed to different levels or are equipped with nested piezometers to measure vertical variations of groundwater level and quality. The purpose of these boreholes is to provide an adequate understanding of the hydrogeology and geochemistry of the area, to calibrate a mathematical model of the aquifer that will be used to predict the effects of recharge and abstraction, and to monitor groundwater levels and quality. (Baker-IVI)
W84-05049

ISOTOPICAL DIFFERENTIATION OF GROUNDWATER OF DIFFERENT HYDROGEOLOGIC ORIGIN,
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
M. A. Geyh, and G. Michel.
Journal of Hydrology, Vol. 59, No. 2, p 161-171, October, 1982. 6 Fig, 1 Tab, 9 Ref.

Descriptors: *Water supply development, *Groundwater management, *Tritium, *Weser River Valley, *West Germany, Limestone, Aquifer recharge, Isotope studies, Geohydrology, Leaching.

In connection with the construction of a new pumping station for public water supply in the Weser River valley at Hoxter, Germany, it was necessary to determine the origin of the groundwater to be exploited. Tritium concentrations in groundwater samples collected from various production and observation wells in the area during the summer of 1980 ranged from 15 to 70 TU. Both the isotopic and hydrochemical data favor the hydrogeological model in which the groundwater in the solution basin of the Weser Valley at Hoxter originates mainly from the Muschelkalk Formation. The hydrogeologic survey of this area yielded an improved geologic profile which clearly shows a hydraulic connection between the porous aquifer in the solution basin and the limestone of the Muschelkalk. In contrast to the previous geological concept, it is now assumed that the solution basin was formed by leaching of saline rock of the Rot Formation (upper Buntsandstein) instead of rock of the Zechstein Formation. (Baker-IVI)
W84-05133

MEETING PEAK DEMAND IN DRINKING WATER SUPPLY BY GROUND WATER RESERVOIRS (SPITZEN - BEREITSTELLUNG IN DER TRINKWASSERVERSORGUNG MIT HILFE VON GRUNDWASSERSPEICHERN),
Energie-und Wasserversorgung A.G., Nuerenberg (Germany, F.R.).
C. Pob.
Wasserwirtschaft, Vol. 73, No. 6, p 169-175, June, 1983. 6 Fig, 2 Tab, 11 Ref.

Descriptors: *Peak demand, *Drinking water supply, *Groundwater reservoirs, Groundwater availability, Groundwater potential, Conjunctive use, Water deficit, Water supply development, Water supply.

Many water facilities must accommodate peak demand schedules. In so doing elaborate storage systems incurring expenses are utilized. The use of small accessable groundwater reservoirs for supplementing the peak demand is discussed. Using the nearby groundwater reservoirs, costs for drinking water supply may be lowered. Required reservoir capacity and advantages and disadvantages of ground water reservoirs are discussed. Drainable pore water in natural uncohesive granular soils for unconfined water table are analyzed for groundwater reservoir tapping efficiency. The planned utilization of a natural groundwater reservoir with considerations on a system of wells to meet peak demand are discussed. (Murphy-IVI)
W84-05242

INTEGRATION OF SURFACE WATER WITH GROUNDWATER RESOURCES AIDED BY NUMERICAL MODELLING,
Pavia Univ. (Italy). Inst. of Hydraulics.
M. Fugazza, M. Gallati, U. Moisello, and L. Natale.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 155-168, 1983. 6 Fig, 1 Tab, 8 Ref.

Descriptors: *Confined aquifers, *Groundwater management, *Philippines, Water resources development, Finite element analysis, Model studies, Numerical models, Irrigation, Water demand, Water supply development, Planning, Water management.

The possibility of a gradual extension of the irrigable area of the Tarlac Irrigation System was studied. The system is located in the alluvial plain of Luzon Island in the Philippines. The extension would be made by integrating groundwater with surface water supplied from a reservoir. Aquifer exploitation was studied, adopting the criterion that groundwater is a very expensive resource to be turned to only in severe drought years. The objectives of the study were to plan the distribution of the wells so as to minimize the pumping cost and to establish a policy for the well management in conjunction with the reservoir operation. Different schemes of the combined system management were analyzed on the basis of the climatic and hydrological regime over the period 1950-1972. For this period the monthly water requirements of different crops and monthly values of aquifer recharge were computed. The economic analyses were performed using present prices of agricultural products and power together with several different hypotheses about future prices. A finite element model of the semiconfined aquifer was postulated and calibrated. The importance of the return flow from irrigation was also tested. Simulations of exploitation schemes provided a detailed forecast of the aquifer response to the irrigation demands. (Baker-IVI)
W84-05303

OPTIMIZATION OF GROUNDWATER ABSTRACTION FROM A COASTAL AQUIFER,
Institute of Hydrology, Wallingford (England).
E. H. Morel, and A. B. Birtles.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 169-182, 1983. 7 Fig, 8 Tab.

Descriptors: *Mathematical models, *Groundwater management, *Coastal aquifer, Aquifers, Jacobian elliptic function, Pumping, Unconfined aquifers, Saline water intrusion, Drawdown.

An analytical mathematical model, based on Jacobian elliptic functions, has been used to identify feasible wellfield locations and pumping rates for large scale abstraction from an unconfined coastal aquifer. The requirement to provide water of an acceptable quality implies a need to limit the extent of saline intrusion at the coast, and to limit drawdowns in the vicinity of the river. Permissible wellfield locations are restricted to bands which run parallel to the coast. Results indicate that the cheapest wellfield design would be a single large wellfield. However, because of the need to provide at least a minimum supply to the city until a new supply can be installed, a better solution may well be for two wellfields supplying a total of 66% of the recharge even though this would be more expensive. These wellfields would be located closer to the coast. The optimum wellfield location has been found to be relatively insensitive to the actual amount of the annual average recharge to the aquifer. (Baker-IVI)
W84-05304

METHOD OF CALCULATING THE CONCENTRATION OF DEPOSIT AROUND AN INJECTION WELL,
Krakow Technical Univ. (Poland). Faculty of Sanitary and Environmental Engineering.
W. Dabrowski.
Water Research, Vol. 18, No. 6, p 709-717, 1984. 9 Fig, 10 Ref.

Descriptors: *Filtration, *Model studies, Mathematical equations, Balance equation, Injection wells, Permeability, Screens, Aquifer recharge.

In modeling deep radical filtration, the balance equation in a simplified form is usually taken into account. This simplification causes an error in modeling. A simple method of calculating the value of this error is presented. An inequality is derived from the equations analogous to the Herzig-Leclerc-Le Goff equations. This inequality can be used for calculating the concentration of deposit around an injection well. The full balance equation for solid particles and the kinetic equation in the general form are taken into consideration. The maximum relative error of the method is calculated. The deep radical filtration through the uniform and non-uniform porous media is considered. (Baker-IVI)
W84-05317

STABLE-ISOTOPE GEOHYDROLOGY OF THE LOWER MANER BASIN, ANDHRA PRADESH, INDIA,
National Geophysical Research Inst., Hyderabad (India).
B. Kumar, R. N. Athavale, and K. S. N. Sahay.
Journal of Hydrology, Vol. 59, No. 3-4, p 315-330, November, 1982. 7 Fig, 3 Tab, 12 Ref.

Descriptors: *Groundwater management, *Isotope studies, Water resources development, Semi-arid regions, Lower Maner Basin, Andhra Pradesh, India, Maner River, Irrigation, Precipitation.

Hydrogen (D/H) and oxygen (18/16) isotopic ratios were measured in precipitation-, lake-, stream- and well-water samples collected from the Lower Maner Basin, Andhra Pradesh, India during 1976-77. Granites, sandstones, quartzites and shales comprise the main lithological units exposed in the basin, which has a semi-arid climate and an average annual rainfall of 1000 mm. The basin is characterized by lakes and tanks of varying capacities. The meteoric water line for the Basin is similar to the global meteoric water line. Discharge in the Maruvancha Stream, which is the only perennial tributary to the Maner River, consists largely of return flow of irrigation water. The relative contribution of surface and groundwater to the discharge during a low-flow month was approximately 80% and 20%, respectively. Isotopic ratios of well waters show different degrees of enrichment vis-a-vis the weighted mean isotopic ratios for pecipitation waters. The post- and pre-monsoon samples collected from the same wells, having a time gap of about 6 months, have generally identical isotopic ratio values, indicating there is no substantial loss of groundwater due to evaporation from the zone of saturation. Isotopic ratios of most of the well samples indicate percolation of precipitation as the main source of recharge. The groundwater of the basin can be classified into two isotopical types, consistent with lithology and degree of compactness of the formations. (Baker-IVI)
W84-05344

4C. Effects On Water Of Man's Non-Water Activities

TIMBER HARVESTING AND FLOODING,
Plum Creek Timber Co., Inc., Missoula, MT.
S. Hess.
Journal of Soil and Water Conservation, Vol. 39, No. 2, p 115-117, March-April, 1984. 3 Fig, 9 Ref.

Descriptors: *Flood control, *Forest management, *Channel erosion, Clear-cutting, Logging, Cutting management, Erosion control, Erosion, Storms, Snow, Rainfall, Watersheds, Cabin Creek Watershed, Washington.

An evaluation was undertaken of flooding in the Cabin Creek watershed, which lies on the east slope of the Cascade Mountains near Easton, Washington. This drainage has been managed intensively for timber production over the past 25 years, during which time flooding has been a recurring problem. Cabin Creek enters the Yakima River near the community of Easton. Severe channel erosion occurred in December 1975 and 1977 as a result of extremely high flows produced by major rain-on-snow storms. Research has consistently demonstrated that wet-mantle flood peaks are not significantly affected by the presence or absence of vegetation. Management activities in the Cabin Creek watershed have been fairly consistent since timber management began in 1958. There was no apparent relationship between channel erosion and the percentage of upstream timber that had been removed. Debris torrents from tributary streams in the Cabin Creek watershed could all be traced to mass failures on adajcent slopes. These mass failures came from roads, clearcuts, and undisturbed areas. Mobile organic debris accounted for much of the flood damage that occurred. These findings support the theory that channel erosion occurs primarily as the result of floods from major winter storms. (Baker-IVI)
W84-05056

4D. Watershed Protection

EFFECTS OF FOREST CLEARCUTTING IN NEW ENGLAND ON STREAM CHEMISTRY,
Northeastern Forest Experiment Station, Durham, NH.
For primary bibliographic entry see Field 5B.
W84-05114

SEDIMENTATION IN NADIS IN THE INDIAN ARID ZONE,
Central Arid Zone Research Inst., Jodhpur (India). Div. of Basic Resources Studies.
K. D. Sharma, and P. C. Chatterji.
Hydrological Sciences Journal, Vol. 27, No. 3, p 345-352, September, 1982. 5 Fig, 3 Tab, 4 Ref.

Descriptors: *Nadis, *India, *Sedimentation, *Water supply, Sediment yield, Arid zone, Watershed management, Vegetation, Silt traps, Ponds.

The people of the Indian Arid Zone harness the meager precipitation in small earthen dugout/embankment ponds called Nadis. This is an ancient practice and the Nadis are the most important resources of the region; water from them is consumed by humans and livestock. Water from Nadis is available for 2 to 12 months, depending upon the drainage basin characteristics, the amount of rainfall received, and its distribution. Nadis are subjected to heavy sedimentation due to erratic and torrential rainfall in sandy and eroded rocky basins. Sediment yield depends upon the physiography, lithology, basin characteristics and the rainfall intensity and amount. Coarse to medium grained, loose and less compact formations lose more sediments with the increasing rainfall and basin slope than the fine-grained, hard and compact formations. The sediment input can be reduced appreciably by allowing vegetation in the basins, and by constructing silt traps at the entrance of the Nadi. (Moore-IVI)
W84-05291

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

DETERMINATION OF TRACES OF INORGANIC POLLUTANTS (CU, PB, CD, ZN) IN WATER, BY DIFFERENTIAL PULSE ANODIC STRIPING VOLTAMMETRY AT A ROTATING MERCURY FILM ELECTRODE (DOSAGE DE MICOPOLLUANTS MINERAUX DES EAUX, (CU, PB, CD, ZN), PAR VOLTAMPEROMETRIE DE REDISSOLUTION ANODIQUE IMPULSIONNELLE SUR ELECTRODE TOURNANTE A FILM DE MERCURE),
M. Bouzanne.
Analusis, Vol. 9, No. 10, p 461-467, December, 1981. 5 Fig, 11 Ref.

Descriptors: *Trace metals, *Copper, *Lead, *Cadmium, *Zinc, *Pulse anodic stripping voltammetry, *Rotating mercury film electrode, Measuring instruments, Performance evaluation.

Among advanced electrochemical methods, the various anodic stripping techniques seem likely to meet the combined requirements of sensitivity, accuracy, swiftness and simplicity necessary for the determination of trace inorganic pollutants in waters. The choice of the method, of some analytical devices (rotating mercury film electrode, rapid desoxygenation apparatus) and procedure has been made in view of fast determination and in situ monitoring. The deoxygenation method allows the treatment of a 10 ml sample in 80 s. Under the best conditions, some nanogram/liter of Cu, Pb, Cd, Zn can be detected after a 15 min. electrolysis. In the microgram/liter range, the simultaneous determination of 3 to 4 elements by known addition method is possible within 15 min. At this concentration level, the relative standard deviation for 8 successive measurements is about 1 to 2%. (Author's abstract)
W84-04809

MEASURING AND PREDICTING WATER QUALITY IN RECREATION RELATED TERMS,
Resources for the Future, Inc., Washington, DC.
For primary bibliographic entry see Field 6B.
W84-04820

POLYNUCLEAR AZAARENES IN WOOD PRESERVATIVE WASTEWATER,
Pittsburgh Univ., PA. Graduate School of Public Health.
J. Adams, and C.-S. Giam.
Environmental Science and Technology, Vol. 18, No. 5, p 391-394, May, 1984. 2 Fig, 2 Tab, 42 Ref.
National Science Foundation Projects OCE 80-19601 and OCE 77-12482.

Descriptors: *Pollutant identification, *Organic compounds, *Public health, *Wood preservatives, Hazardous materials, Wastewater treatment, Activated sludge processes, Polynuclear azaarenes, Azaarenes, Creosote, Preservatives, Quinoline, Isoquinoline, Benzoquinoline, Acridine.

Polynuclear azaarenes in a creosote-pentachlorophenol wood preservative wastewater were analyzed. The gas chromatogram of the basic fraction isolated from the creosote-PCP wood preservative wastewater indicated that there were numerous compounds present. By use of GC retention time and mass spectral analysis, polynuclear azaarenes such as quinoline, isoquinoline, and alkyl- and benzo-substituted azanaphthalenes were characterized at a total concentration of 1300 mg/kg. The presence of polynuclear azaarenes in this wastewater implies that an adverse effect on environmental quality can result from improper disposal of such wastes. Acknowledging the findings that quinoline and isoquinoline resist activated sludge treatment of wastewaters leads to the suggestion that the determination of polynuclear azaarenes be included in hazardous wastes analytical protocols. (Baker-IVI)
W84-04892

ANALYSIS AND CHARACTERIZATION OF NATURAL ORGANIC MATTERS IN FRESHWATERS; I. STUDY OF ANALYTICAL TECHNIQUES,
Geneva Univ. (Switzerland). Dept. of Inorganic, Analytical and Applied Chemistry.
J. Buffle, P. Deladoey, J. Zumstein, and W. Haerdi.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 325-362, 1982. 20 Fig, 7 Tab, 28 Ref.

Descriptors: *Water analysis, *Organic compounds, Fulvic acid, Natural waters, Lakes, Ponds, Thermogravimetry, Fluorescence, Ultrafiltration, Organic matter, Humic compounds.

Several analytical techniques have been studied for the analysis and characterization of humic and fulvic compounds of freshwaters. Forty-seven water samples, with various characteristics, were taken from marshes, ponds, rivers and lakes. Water extracts of soils and in vitro decomposition products of leaves were also studied for comparison.

Two methods were tested for the measurement of dissolved organic carbon. The factors which may influence the signal, in particular the injected volumes and the nature of organic compounds were also tested. The use of thermogravimetry was studied for the measurement of concentration and characterization of dissolved organic matter. This method was useful for the latter purpose, but it may be strongly influenced by the nature and concentration of inorganic ions. The role of the nature of samples, of pH and of iron content, on UV absorption of samples, was also studied. The freezing technique was investigated for preconcentration of organic matter. The effectiveness of the various techniques may be strongly affected by the concentration of fulvic compounds. Adsorption on freshly precipitated calcium carbonate could be one of the important processes of elimination of organic matter. (Baker-IVI)
W84-04916

INFLUENCE OF METAL COMPOUNDS ON FULVIC ACID/MOLYBDENIUM BLUE REACTIVE PHOSPHATE ASSOCIATIONS,
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
C. Steinberg, and G. F. Baltes.
Archiv fur Hydrobiologie, Vol. 100, No. 1, p 61-71, April, 1984. 4 Fig, 18 Ref.

Descriptors: *Phosphates, *Metals, *Fulvid acid, *Molybdenum blue, Natural waters, Organic compounds, Molecular weight, Ultraviolet radiation, Iron, Manganese, Peat bog.

In natural waters, a bimodal distribution of phosphates, which may be determined by common molybdenum blue methods without hydrolysis, can often be found by separating dissolved organic water constituents, mainly fulvic acids. The water tested in the present study was collected form the Latschensee, a raised peat bog. Fulvic and humic acids in this lake derived mainly from the decomposition of Spagnum mosses. Separation of fulvic acid/molybdenum blue reactive phosphorus (MRP) compounds from the peat bog water using gel permeation chromatography (Sephadex G-25) revealed a bimodal distribution pattern of phosphates: low molecular weight (lmwt) and high molecular weight (hmwt) MRP. Hmwt MRP seems to be sensitive to UV-radiation. The additions of iron ions (up to 1.5 mg/l Fe) and of manganese in low concentrations caused decreases of lmwt MRP and simultaneous increases of hmwt MRP by formation of colloids. Higher amount additions of manganese ions (up to 5.0 mg/l Mn), as well as each addition of cadmium ions, led to decreases of hmwt MRP and increases of lmwt MRP. The latter effect is most likely due to catalytic cleavage of hmwt MRP by the added metals. An electrostatic mechanism was probably not responsible for the release of phosphate in the test series, as alkaline conditions were not present. (Moore-IVI)
W84-05004

MERCURY POLLUTION IN THE WATERS AROUND HARBOORE TANGE AND LIMFJORD, DENMARK,
Marine Pollution Lab., Charlottenlund (Denmark).
H. U. Riisgard.
Marine Pollution Bulletin, Vol. 15, No. 4, p 129-133, April, 1984. 6 Fig, 12 Ref.

Descriptors: *Mercury, *Denmark, *Monitoring, *Coastal waters, Fjords, Mussels, Chemical industry, Waste dumps, Water pollution sources, Heavy metals, Bioindicators.

High concentrations of mercury have been measured in mussels (Mytilus edulis) collected in two 'hot spot' areas: (1) near a closed-down chemical factory on the west coast of the Limfjord, and (2) or groynes in the immediate vicinity of a chemical deposit in the dunes on the Danish west coast. By collecting comparable samples of mussels from chains of buoys, the mercury pollution in the western Limfjord could be traced 50-100 km into the central and innermost parts of the Limfjord as a gradual decreasing mercury concentration gradient. By collecting mussels from groynes north and south of the chemical deposit, it was possible to monitor the relative extent of the mercury leakage to the North Sea before and after the excavation of the deposit. The investigations have demonstrated the applicability of M. edulis as a monitoring organism for mercury when importance is attached to concentration gradients and distribution patterns in well defined and homogeneous samples of mussels collected from natural populations. (Author's abstract)
W84-05078

COMPARISON OF ISOLATION PROCEDURES FOR SALMONELLAS FROM POLLUTED WATER USING TWO FORMS OF RAPPAPORT'S MEDIUM,
Scottish Salmonella Reference Lab., Glasow.
C. R. Fricker.
Journal of Applied Bacteriology, Vol. 56, No. 2, p 305-309, April, 1984. 4 Tab, 19 Ref.

Descriptors: *Salmonella, *Bacterial analysis, Water analysis, Water pollution, Novobiocin.

The efficiency of Rappaport's broth (RB10) and Rappaport's broth containing novobiocin (NRB10) were compared for the isolation of salmonellas from polluted water, both as direct enrichment media and after pre-enrichment in buffered peptone water. Ninety samples were examined and 41 were found to contain salmonellas by at least one of the procedures used. Direct inoculation of the sample into RB10 resulted in the recovery of salmonellas from only 29.3% of the samples found to be positive. The use of NRB10 as a direct enrichment medium increased the percentage recovery to 78-0% of the total positive samples. Pre-enrichment in buffered peptone water allowed the recovery of salmonellas from a total of 41 samples whereas direct enrichment recovered them from only 32. No significant difference was demonstrated in the efficiencies of RB10 and NRB10 in recovering salmonellas after pre-enrichment in buffered peptone water. Three selective agars were used; no significant difference in their ability to recover salmonellae was demonstrated. (Author's abstract)
W84-05109

SENSORY ANALYSIS OF ODOROUS WATER SAMPLES,
Ghent Rijksuniversiteit (Belgium). Faculteit Landbouwwetenschappen.
H. R. Van Langenhove, D. Teerlinck, F. A. Van Wassenhove, and N. M. Schamp.
Journal of the Water Pollution Control Federation, Vol. 56, No. 4, p 351-354, April, 1984. 3 Fig, 2 Tab, 9 Ref.

Descriptors: *Water analysis, *Odors, Organoleptic properties, Pollutant identification, Chemical analysis, Dynamic olfactometry.

Results of the analysis of polluted water samples by the ASTM D 1292 method are compared with results obtained by dynamic olfactometry. The analysis showed the ASTM D 1292 method to be four times as sensitive as dynamic olfactometry. Moreover the variance among individual odor thresholds is significantly smaller in the ASTM D 1292 method. Comparing of results obtained by ASTM D 1292 at 40 and 20 degrees C shows that temperature difference enhances odor dilution ratios by a factor of two. The remaining difference between ASTM D 1292 and dynamic olfactometric results is attributed to methodological causes. From a practical viewpoint dynamic olfactometry is more convenient than ASTM D 1292. Dynamic olfactometric results are obtained within 1 hour, using a panel of 10 persons, while an analysis with ASTM D 1292 with five persons requires half a day. (Baker-IVI)
W84-05141

SOLVENT EXTRACTION-SPECTROPHOTOMETRIC DETERMINATION OF PHOSPHATE WITH MOLYBDATE AND MALACHITE GREEN IN RIVER WATER AND SEA-WATER,
Okayama Univ. (Japan). Dept. of Chemistry.
S. Motomizu, T. Wakimoto, and K. Toei.
Talanta, Vol. 31, No. 4, p 235-240, April, 1984. 2 Fig, 6 Tab, 21 Ref.

Descriptors: *Water analysis, *Phosphates, *Spectrophotometry, Molybdate, Malachite green, River water, Seawater, Orthophosphate, Extraction.

Most spectrophotometric methods for phosphate are based on the formation of a heteropoly acid with molybdate. The heteropoly acid formed can be extracted into an organic phase, as an ion-pair with a cationic dye. An attempt was made to improve the extractability of the ion-pair formed between Malachite Green and molybdophosphate for use in this method. Molybdophosphate, formed between orthophosphate and molybdate in sulfuric acid solution, is extracted into a mixture of toluene and 4-methylpentan-2-one (1:3 v/v) with Malachite Green as counter-ion. A single extraction with equal phase volumes gives an apparent molar absorptivity for phosphate of 230,000 l/mole/cm at 630 nm; the absorbance of the reagent blank is 0.03. With an organic to aqueous phase-volume ratio of 1:10, the molar absorptivity is 250,000 l/mole/cm and the absorbance of the reagent blank 0.08. By the proposed method, ng/ml levels of phosphorus can be determined, and the detection limit is about 0.1 ng/ml. The standard deviation and relative standard deviation for the determination of phosphorus in tap water (4.3 ng/ml) are 0.05 ng/ml and 1.1%, respectively. The method can also be applied to the determination of phosphorus in river water and sea-water. Phosphorus occurs in natural water as orthophosphate, condensed phosphate and organically-bound phosphorus; only orthophosphate can be directly determined by this method. (Moore-IVI)
W84-05151

COMBINED EFFECT OF BODY SIZE, SEASON, AND LOCATION ON TRACE ELEMENT LEVELS IN MUSSELS (MYTILUS EDULIS),
Simon Fraser Univ., Burnaby (British Columbia). Dept. of Chemistry.
J. D. Popham, and J. M. D. Auria.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 1-14, January, 1983. 5 Fig, 5 Tab, 33 Ref, 3 Append. NSERC grants G0161 and G0507.

Descriptors: *Mussels, *Bioindicators, *Heavy metals, Trace elements, Monitoring, Seasonal variation, Body size, Marine environment, British Columbia.

Mussels are recognized as sentinels of heavy element marine pollution since their metal concentrations reflect the seawater concentrations in which they live. The usefulness of mussels as universal indicators may be dependent on the effects of other factors such as body size and season on heavy metal concentrations in specimens. Specimens of Mytilus edulis (mussels) were collected at one-month intervals over a one-year period from two locations in Burrard Inlet, British Columbia (B.C.) and less frequently from other locations in the S.W. region of B.C., and analyzed for concentrations of Mn, Fe, Cu, Zn, Br, Pb, and Sr using X-ray energy spectroscopy. Size and condition of the mussels were recorded at the same time. The data were analyzed using multiple linear regression with size and season as predictor variables and trace metal contents as criterion variables. Trace element concentrations in mussels are dependent upon body size and season of collection, and the way trace element concentrations are influenced by size and season is dependent upon the type of environment of the mussels. The values of the regression coefficients changed according to whether or not the mussels were collected from a polluted environment. Principal component analysis of the correlation matrix of the variables yielded three principal components one of which can be used to ascertain whether or not mussels were collected from either a polluted or an unpolluted environment. (Moore-IVI)
W84-05169

COPPER ACCUMULATION IN THE BAY SCALLOP, ARGOPECTEN IRRADIANS,
Environmental Research Lab., Narragansett, RI.
G. E. Zaroogian, and M. Johnson.

Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 127-133, March, 1983. 6 Fig, 2 Tab, 26 Ref.

Descriptors: *Scallops, *Copper, *Bioaccumulation, *Bioindicators, Heavy metals, Marine environment, Argopecten, Body size, Spawning.

The kinetics of copper accumulation by the bay scallop, Argopecten irradians, was studied to establich patterns and examine the bay scallop as a possible biological indicator of copper in nearshore marine waters. Adults of the bay scallop were held in flowing seawater containing 5 or 10 micro g Cu/kg at ambient temperature and salinity. After eight weeks, scallops contained up to 91 and 310 micro g Cu/g dry weight, respectively, in the total soft parts. Copper uptake was linear over time. There was no significant relationship between dry weight and copper content (micro g) in adductor muscle, visceral mass or total soft tissue. There was a significant inverse relation between dry weight and copper concentration (micro g/g) in adductor muscle, visceral mass, and total soft tissue. A decrease in copper content occurred in the visceral mass and total soft parts during spawning in the control and 5 micro g Cu/kg treatments. There was no apparent decrease in copper concentration during spawning in any tissue of scallops from all three treatments. A. irradians is an excellent bioindicator of copper, since accumulation was observed in the visceral mass at a seawater copper concentration of 1.8 micro g/kg. Size is an important consideration when sampling scallops from natural populations since small scallops appear to have higher concentrations of copper than large scallops. (Moore-IVI)
W84-05176

CONCENTRATIONS OF LEAD, CADMIUM, MERCURY, AND COPPER IN THE CRAYFISH (PACIFASTICUS LENIUSCULUS) OBTAINED FROM A LAKE RECEIVING URBAN RUNOFF,
Washington Univ., Seattle. Dept. of Environmental Health.
M. D. Stinson, and D. L. Eaton.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 693-700, November, 1983. 4 Fig, 3 Tab, 20 Ref.

Descriptors: *Crayfish, *Bioindicators, *Lead, *Cadmium, *Mercury, *Copper, Urban runoff, Heavy metals, Combined sewer overflows, Storm wastewater, Water pollution effects, Food.

Commercially caught crayfish (Pacifasticus leniusculus) were placed in a municipal lake below a combined sewer overflow outfall and a storm drain outfall associated with elevated sediment metal concentrations. Abdominal muscle, viscera, and exoskeleton from each crayfish were analyzed for mercury, cadmium, lead, and copper. Crayfish metal concentrations for each sampling site were evaluated relative to unexposed samples from the commercial catch and samples held in the laboratory. Results indicated that 1) mercury accumulated in muscle tissue, highest cadmium concentrations were in the viscera, and highest lead concentrations were in the exoskeleton, 2) uptake of copper is well-regulated by the organism at non-toxic water concentrations, and 3) viscera concentrations of cadmium, lead and copper tended to be higher and more variable than in muscle tissue. A significant correlation was found between body weight and muscle mercury concentration. Relative to allowable limits for metals in foods, there was not sufficient accumulation of any metal to indicate that a significant health hazard would result from consumption of these organisms. These data indicate that analysis of trace metals in various body parts of P. leniusculus may be a useful biological indicator of trace metal pollution of freshwater lakes and streams. (Author's abstract)
W84-05199

SOURCES OF VARIABILITY IN ACCUMULATION OF HEAVY METALS BY FISHES IN A ROADSIDE STREAM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
J. J. Ney, and J. H. Van Hassel.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 701-706, November, 1983. 1 Fig, 2 Tab, 44 Ref.

Descriptors: *Heavy metals, *Monitoring, *Fish, Roads, Bioaccumulation, Lead, Nickel, Cadmium, Zinc, Sunfish, Bass, Sucker, Dace, Darter, Variability.

Monitoring programs to assess heavy metals contamination of fish communities are hindered by the lack of a standard sampling protocol to control sources of extraneous variation. Such a protocol should include a rationale for specimen selection derived from an understanding of the factors that influence bioaccumulation of metals by fish. Interspecific variations in lead, nickel, cadmium, and zinc concentrations among six species of fish from a highway-contaminated stream were investigated as functions of differences in habitat (sediment contact) and morphology (percentage axial muscle). The species of fish studied include redbreast sunfish, rock bass, northern hog sucker, white sucker, blacknose dace, and fantail darter. Association with stream sediment appeared to influence whole-body metals accumulation but percentage muscle did not. Intraspecific variation in whole-body metal concentrations was not positively related to length (as an index of duration of exposure) in any species. Lead and nickel content of bone and cadmium content of kidney increased consistently between ages 2 and 5 in white sucker, the only species subjected to tissue analysis across age groups. Biological monitoring to assess chronic heavy metal pollution should focus on long-lived benthic species and be directed at tissues with demonstrated affinities for particular metals. (Moore-IVI)
W84-05200

ROLE OF MACROPHYTES IN AQUATIC ECOSYSTEMS AND MANAGEMENT OF FRESHWATER RESOURCES,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
A. K. Pandit.
Journal of Environmental Management, Vol. 18, No. 7, p 73-89, January, 1984. 3 Fig, 9 Tab, 47 Ref.

Descriptors: *Macrophytes, *Water management, *Ecosystems, Lakes, Rivers, Aquatic plants, Aquatic fauna, Nutrients, Fish food, Pollutant identification.

Macrophytes, as a component of freshwater ecosystems, have diverse roles to play in the functioning of these ecosystems. The most important of their roles is in maintaining an ecological balance. Another possible use of aquatic plants, especially submerged species, is as green manure. Macrophytes are also useful indicators of water quality. Macrophytes also indicate habitat conditions such as the rate of flow and nature of the substrate. In addition to their use as food by aquatic fauna, macrophytes also provide suitable breeding and sheltering places for various aquatic fauna, the most favorable sites for breeding macro-invertebrates being the leaves and stems of submerged plants. Macrophytes, especially submerged species, support large quantities of a variety of epiphytic algae and a periphyton which is to some extent the life environment of invertebrates and fish. The nutritive importance of aquatic flora and the fauna feeding on them is depicted in a food web showing complex trophic relationships where a basic source of food energy is supplied by macrophytic plants. Analysis of data for 18 macrophytic species belonging to four different life-form types collected over a period of 6 months from Dal Lake revealed that most of the available foodstuffs contained rather high amounts of crude protein. Since they are such a vital part of freshwater ecosystems, macrophytes are important in the management of water resources. (Baker-IVI)
W84-05306

ANALYSIS OF ORGANIC COMPOUNDS IN WATER SAMPLES BY GAS CHROMATOGRAPHY - MASS SPECTROMETRY,
Indiana State Univ., Terre Haute. Dept. of Chemistry.
J. R. Siefker, and N. B. Sapuan.
Proceedings of the Indiana Academy of Sciences, Vol. 92, p 271-273, 1982. 2 Ref.

Descriptors: *Pollutant identification, *Organic compounds, Lakes, Wells, Wastewater analysis, Deming Park Lake, Dobbs Park Lake, Fowler Park Lake, Terre Haute, Indiana, Wabash River, Seymour, Toluene, Chloromethanes, Benzenes, Bromomethanes, Cyclohexanes, Naphthalenes.

The presence of volatile organic compounds was investigated in selected water samples collected from places where a certain degree of water pollution was suspected: including well water from several places in Indiana; Wabash River water; Deming, Dobbs and Fowler Park lake water; sewage treatment plant water; and tap water. A purge and trap method was used for the analysis. Some of the well water samples were taken from Seymour, Indiana. For 12 years more than 60,000 drums of chemical wastes were stored in Seymour's Freeman Field Industrial Park. A definite spectrum for toluene was obtained from some of the samples. While other spectra gave no definite results, 1-methyl naphthalene, 1,2-dimethyl naphthalene, and 1,1-biphenyl were indicated. Deming Park Lake water showed toluene and 1,2-dichloropropene; Dobbs Park Lake contained benzeneacetonitrile methylene. Walsh River water contained 1-ethyl-3 methylbenzene. Terra Haute Wastewater Plant samples gave spectra indicative of 3,3-dichloropropene, 1,2-dichlorobenzene, toluene, 1,4 dimethylbenzene, tetrachloroethane, and 1-(1-propynyl)-cyclohexane. One sample of Terra Haute tap water gave indication of dibromomethane and dibromochloromethane. (Baker-IVI)
W84-05309

LOW LEVEL SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF SULFITE IN WATER,
Los Angeles County Sanitation Districts, Whittier, CA.
J. E. Haskins, H. Kendall, and R. B. Baird.
Water Research, Vol. 18, No. 6, p 751-753, 1984. 2 Fig, 4 Tab, 4 Ref.

Descriptors: *Water analysis, *Wastewater analysis, *Sulfite, *Spectrophotometry, Sulfur dioxide, Acidity, Secondary wastewater treatment, Pollutant identification.

A method for determining low levels of sulfite in water is described based on the liberation of sulfur dioxide from an acidified water sample by purging with nitrogen gas and re-absorbing it in a solution containing ferric ion and 1,10-phenanthroline. The ferric ion is reduced to ferrous ion by the sulfur dioxide and the orange tris-(1,10-phenanthroline)iron(II) complex is formed. After removing the excess ferric ion with ammonium bifluoride to stop further color development, the stable complex is measured colorimetrically at 510 nm. The detection limit is 0.01 mg/l sulfate. The method is subject to several possible interferences. Sulfamic acid is added to remove nitrite as a negative interference. Sulfide and thiosulfate will give a positive interference if present, but these would normally be expected only in samples containing certain industrial discharges. Sulfide may be removed by adding 0.5 g zinc acetate with sufficient sodium hydroxide solution to produce a fast settling floc, and analyzing the supernatant of the settled sample. If thiosulfate is present it is necesary to differentiate between sulfite and thiosulfate by using the iodometric titration method with and without the elimination of sulfite by a 5 min reaction with 2 ml formaldehyde. This method may be a suitable alternative to the iodometric titration procedure when analysis of low levels of sulfite ion in water and wastewater is desired. (Baker-IVI)
W84-05321

COMPARISON OF SEDIMENTS AND ORGANISMS IN IDENTIFYING SOURCES OF BIOLOGICALLY AVAILABLE TRACE METAL CONTAMINATION,
Geological Survey, Menlo Park, CA.
E. A. Thomson, S. N. Luoma, C. E. Johansson, and D. J. Cain.

Water Research, Vol. 18, No. 2, p 755-765, 1984. 8 Fig, 25 Ref.

Descriptors: *Sediments, *Bioindicators, *Pollutant identification, San Francisco Bay, Metals, Copper, Zinc, Lead, Urban runoff, Trace metals, Harbors, Bays.

Sediments and an indicator organism were used to assess the relative importance of secondary sewage, urban runoff, a landfill containing metal-enriched ash wastes and a yacht harbor in contributing to Ag, Cu and Zn enrichment in South San Francisco Bay. Spatial gradients in sediments and organisms showed Cu and Ag enrichment originated from sewage discharge, whereas Zn enrichment orginated from both sewage and urban runoff. Elevated concentrations of Cu in the sediments of the yacht harbor resulted from a high abundance of fine particles. The biological availability of Cu, Ag and Zn did not coincide with metal enrichment in sediments. The availability of Cu and Ag was greatest nearest the sewage outfall and greater in winter and spring than in summer. The availability of Zn in urban runoff appeared to be lower than the availability of Zn associated with sewage. Where metal concentrations in sediment were elevated simply because of the presence of finer particles, no elevation of metal levels in clams occurred. If organisms are to be used to detect or differentiate sources of pollution, sampling sites must be chosen carefully, especially in water bodies where circulation patterns are poorly known. Sediment analyses proved useful in this study for verifying the presence, and the source, of trace metal contaminants, proving that trends in animals were not the result of purely physiological processes. However, the biological availability of the metal contaminants was not related solely to the concentration of metal discharged or present in the sediment. Compared to sediments, oganisms exhibited greater spatial sensitivity, a greater ability to concentrate metals, and were the more reliable tool for identifying sources of biological contamination. (Baker-IVI)
W84-05322

USE OF SYNCHRONIZED ANALYZERS IN AUTOMATIC WATER QUALITY CONTROL (ZUM EINSATZ VON TAKTANALYSATOREN IN DER AUTOMATISCHEN WASSERBESCHAFFENHEITSKONTROLLE),
Wasserwirtschaftsdirektion Saale-Werra, Halle (German D.R.).
H. Heitmann.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 164-167, May, 1983. 2 Fig, 13 Ref.

Descriptors: *Water quality control, *Water analysis, *Synchronized analyzers, Chemical analysis, Calorimetry, Monitoring.

The effectiveness of automatic water quality control in water and wastewater treatment depends to a great extent upon the availability of analyzers for specific substances found in water, particularly for salt, nutrients, and harmful pollutants. The synchronized analyzer system at the Dresden (German Democratic Republic, GDR) Control Facility is an example of this, and is available in two modes: as titrator with potentiometric point-of-equivalence indication, and as calorimeter. The Dreloba system, developed in the GDR, illustrates the principles of synchronized analyzers: it consists of modules for digital control under pneumatic normal and low-pressure conditions. The analyzer must be installed indoors, with easily accessible supplies of electricity, compressed air, and water samples. The water to be tested usually flows through the dose unit constantly unless it is polluted with particles that clog the valve seat, in which case the valve is programmed to open for a limited time. Analyses can be automatically timed to suit water flow speeds and programmed to omit unnecessary steps, resulting in cost savings. For the monitoring of water polluted with salt, routine conductivity measurements are complemented by automatic potentiometric titrations to determine total water hardness and chloride and hydrocarbon contents. Successful use of the synchronized analyzer as colorimeter depends (in contrast to its use as titrator) on pretreatment of the water sample to remove turbidities. Although progress has recently been made in automatic sample filtration techniques, adequate treatment levels cannot be achieved for all applications. In addition, colorimetric reactions can be handled more easily in an acid environment. The synchronized analyzer can also be used in the automatic conditioning of samples for discontinuous measurement of specific ion activity with sensitive electrodes (e.g., for cyanide analysis, which requires alkalization of the sample). In the titrator with potentiometric indication system mode, the analyzer is universally applicable. (Gish-IVI)
W85-04799

5B. Sources Of Pollution

IDENTIFICATION OF FACTORS AFFECTING NITROGEN AND PHOSPHORUS LOADINGS TO LOUGH NEAGH,
Department of Agriculture for Northern Ireland, Antrim. Freshwater Biological Investigation Unit.
R. H. Foy, R. V. Smith, R. J. Stevens, and D. A. Stewart.
Journal of Environmental Management, Vol. 15, No. 2, p 109-129, September, 1982. 5 Fig, 10 Tab, 46 Ref.

Descriptors: *Nitrogen, *Phosphorus, *Pollution load, *Lough Neagh, *Water pollution sources, Multiple regression analysis, Cycling nutrients, Fertilization.

A stepwise multiple regression analysis was used to identify the factors affecting nitrogen (N) and phosphorus (P) loss rates from six major rivers entering Lough Neagh over the period 1971-1979. Nitrate-N, Kjeldahl-N, soluble reactive P (SRP), soluble organic P (SOP) and particulate P (PP) were analyzed with independent catchment variables reflecting population, land use, industry and run-off rate. Urban population density was the dominant factor accounting for 44.0% of the variability of the SRP regression and the predicted per capita value (1.6 g P/person/day) agreed well with the observed value (1.8 g P/person/day). Milk processing plants contribued 4.6% of the variability and the predicted output was close to field measurements. The log of run-off was also an important determinant and contributed a further 20.8% of the variability, but all of the other variables failed to meet the criterion of significance. Intensity of dairy farming, shown to be highly correlated with N fertilizer usage, contributed 56.7% of the variability to the nitrate-N regression. Twelve % of the N fertilizer applied was lost in drainage water. The log of run-off contributed 21.4% of the variability and roughland was negatively correlated. All point source variables failed to meet the criterion of significance. Of the remaining chemical variables, only the PP regression produced a high R2 value, with the log of run-off being the dominant variable accounting for 43% of the variability. The regression equations were used to calculate total annual inputs to Lough Neagh of SRP and nitrate-N. A rise in the N/P ratio with time was observed. The SRP input could be reduced by 42%, if 90% P removal was practiced at the 18 largest sewage works. (Author's abstract)
W84-04816

INVESTIGATION OF SOURCES OF GROUNDWATER NITRATE CONTAMINATION IN THE BURBANK - WALLULA AREA OF WASHINGTON, U.S.A.,
Nebraska Univ., Lincoln. Conservation and Survey Div.
R. F. Spalding, M. E. Exner, C. W. Lindau, and D. W. Eaton.
Journal of Hydrology, Vol. 58, No. 3/4, p 307-324, September, 1982. 5 Fig, 2 Tab, 48 Ref.

Descriptors: *Water pollution sources, *Groundwater pollution, *Nitrates, *Burbank, *Wallula, *Washington, Water quality, Agricultural wastes, Leachates, test wells, Walla Walla county.

During the past decade the increased emphasis on the quality of drinking water has resulted in expanded groundwater for drinking. The most commonly reported chemical contaminant is nitrate. During the fall and early winter of 1980, groundwater samples were collected from 38 public supply and domestic wells in the Burbank-Wallula area of Washington. Groundwater nitrate-nitrogen (NO3-N) concentrations ranged from 3.9 to 32 mg/l and averaged 10.5 mg/l. Nitrogen isotope composition (delta N-15) of the NO3-N ranged from +1.3 to +16.0 0/00 and averaged +4.1 0/00. The preponderance of low delta N-15 values suggests that agricultural leachates (from oxidation of soil humus or use of nitrogen fertilizers) are the primary source of contamination for the area. Fourteen of the 38 wells were sampled at least twice in a four-month period. The relative invariability in NO3-N levels and delta N-15 in these wells suggests little or no temporal change in either the source or the magnitude of the source. Two additional samples collected in May 1981 from monitoring wells on the perimeter of a cropped field spray-irrigated with cattle waste from an anaerobic lagoon had delta N-15 values for the NO3-N of +12.0 and +18.7 0/00, respectively. The high delta N-15 values in these wells indicate that the NO3-N is predominantly derived from animal waste. (Murphy-IVI)
W84-04853

LEACHING OF A SOLUBLE CHEMICAL UNDER FIELD CROP CONDITIONS,
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
S. J. Smith, L. R. Ahuja, and J. D. Ross.
Soil Science Society of America Journal, Vol. 48, No. 2, p 252-258, March-April, 1984. 3 Fig, 1 Tab, 33 Ref.

Descriptors: *Leaching, *Bromide, *Root zone, *Sorghum-sudangrass, Soil water, Soil profiles, Burns' equation, Levin's equation, Convective-dispersive transport equation, Dispersion coefficient, Plant water potential, Flow velocity.

Movement of relatively nonadsorbed, applied, soluble chemicals is soils plays an important role in determining their availability to plants and associated potential for posing environmental hazards. The leaching pattern of surface-applied bromide is examined in an active rootzone of a sorghum-sudangrass (Sorghum sudanense (Piper) Stapf) crop in Southern Plains field plots. Data were collected for eight soils, comprising five soil orders, over three growing seasons. The position of the leaching front (solute center of mass) was better predicted generally by Burns' equation, which assumes chromatographic-type, sequential mixing of solute with soil water, than by Levin's equation, which assumes the leaching front moves with the velocity of water flowing above field capacity. With both equations effective rainfall was used, by correction for the soil water deficit caused by evapotranspiration above the leaching front. The leaching pattern in the soil profile was described quite well by a simplified version of the convective-dispersive solute transport equation, which assumed constant average values for the dispersion coefficient, D, a plant uptake factor, beta, and flow velocity. Plant uptake of solute was assumed to be proportional to its concentration in soil water during passage through the root zone, with an effective average value of the proportionally constant applicable on a seasonal basis. The average value of D among soils was fairly uniform, 1.36 + or - 0.56 sq cm/d. Therefore, in practice a single value of D will probably suffice for many soils and conditions. Necessary inputs for obtaining flow velocity can be obtained from plant growth and water balance components of CREAMS, or other appropriate models. In the case of beta, some additional information is needed regarding its relationship to specific growth factors. (Murphy-IVI)
W84-04873

METHODOLOGIES TO PREDICT THE MOBILITY AND AVAILABILITY OF HAZARDOUS METALS IN SLUDGE-AMENDED SOILS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
G. Sposito, J. P. LeClaire, and C. S. LeVesque.

Available from the National Technical Information Service, Springfield, VA 22161 as PB84 171099, Price codes: A09 in paper copy, A01 in microfiche. California Water Resources Center Completion Report, Univ. of California, Davis, January, 1984. 156 p, 4 Fig, 4 Tab, 74 Ref.

Descriptors: *Trace metals, *Wastewater, *Sludge, *Sludge disposal, *Solubility, *Effluents, *Soil contamination, Soil chemistry, Bioaccumulation, *Soil disposal fields, Land disposal, Nickel, Copper, Zinc, Cadmium, Lead, Sludge application rates.

Research was undertaken to develop practicable laboratory methods for assessing the solubility and plant-availability of potentially hazardous trace metals accumulating in arid-zone soils receiving sewage effluents or sludges. Sequential extraction of field soil samples with potassium nitrate, water, sodium hydroxide, sodium EDTA, and nitric acid was shown to provide reliable estimates of trace metal solubility and uptake (leaf concentration) by barley, irrespective of soil texture, rate of sludge application, or time during a three-year study period. The total concentrations of the trace metals Ni, Cu, Zn, Cd, and Pb accumulated in two sludge-amended field soils during the project period were comparable with the amounts of these metals sorbed by untreated soils at soil solution concentrations below 100 parts per billion. At these low metal concentrations, the sorption isotherms often exhibited a sigmoid shape that precludes intrepretation of terms of conventional distribution function techniques. Organic forms of the trace metals, particularly copper, were found to increase in importance with the sludge application rate. These organic-metal compounds could be characterized conveniently by electron spin resonance spectrometry. (Snyder-California)
W84-04886

VERTICAL TRANSPORT AND SEDIMENTATION OF HYDROCARBONS IN THE CENTRAL MAIN BASIN OF PUGET SOUND, WASHINGTON,

National Oceanic and Atmospheric Administration, Washington, DC.
T. S. Bates, S. E. Hamilton, and J. D. Cline.
Environmental Science and Technology, Vol. 18, No. 5, p 299-305, May, 1984. 4 Fig, 4 Tab, 30 Ref.

Descriptors: *Sediment transport, *Sedimentation, *Hydrocarbons, *Puget Sound, *Washington, Sedimentation rates, Water pollution, Pollutants, Pollution load, Accumulation.

Hydrocarbons are introduced into the surface waters of the marine environment from runoff and erosion, effluent discharges, atmospheric deposition, and biological sources. Concentrations and vertical fluxes of total carbon, aliphatic hydrocarbons, and polycyclic aromatic hydrocarbons (PAH) were determined in suspended matter and the underlying sediments in the central main basin of Puget Sound, Washington. Suspended matter was collected seasonally at four depths in the water column using sequential sampling sediment traps. The flux of PAH through the 50- and 100-m horizons accounted for 84% of the PAH accumulating in the underlying surface sediments. The concentration of PAH in the suspended matter from these traps, however, was 3 times greater than the concentration of PAH in the surficial bottom sediments. Laterally transported suspended matter in the bottom boundary layer is apparently diluting the PAH during sedimentation. The flux of aliphatic hydrocarbons to the sediments was greater than the accumulation rate in the sediments, indicating an alteration of these hydrocarbons within the water column or differential particle transport. The vertical distributions of hydrocarbons in the bottom sediments showed concentration increases paralleling the urbanization of the Puget Sound basin. (Murphy-IVI)
W84-04890

CHROMIUM UPTAKE AND LOSS IN THE BIVALVES CRASSOSTREA VIRGINICA AND MYTILUS EDULIS,

Environmental Research Lab., Narragansett, RI.
G. E. Zaroogian, and M. Johnson.
Marine Ecology - Progress Series, Vol. 12, No. 2, p 167-173, May, 1983. 3 Fig, 21 Ref.

Descriptors: *Bioaccumulation, *Chromium, *Crassostrea, *Mytilus, Mussels, Bioindicators, Biological magnification, Trace metals, Trace levels.

Chromium uptake and loss by the bivalves Crassostrea virginica and Mytilus edulis were studied at naturally occurring seawater temperature and salinity to determine their potential as an indicator of chromium pollution. After 12 wk treatment with 5 and 10 ppb Cr seawater, mean tissue concentration in oysters, C. virginica, was 3.12 + or - .45 and 5.63 + or - 1.15 micro g Cr/g dry weight, respectively. Mean chromium concentration in mussels, M. edulis, treated with 5 and 10 ppb Cr seawater for 12 wk were 4.83 + or - 1.32 and 9.41 + or - 3.37 micro g Cr/g dry weight, respectively. Significant linear relationships exist between chromium uptake by oysters and mussels and seawater chromium concentrations over the range of concentrations used in this study. A significant inverse relationship exists between tissue chromium concentration and dry weight in both oysters and mussels. Chromium concentration in oysters continued to increase during spawning, whereas it decreased in mussels. After holding chromium treated mussels in ambient flowing seawater for 28 wk, a 61 and 70% loss of chromium occurred in mussels treated with 5 and 10 ppb Cr, respectively. When treated similarly, oysters from both 5 and 10 ppb Cr treatments lost 42% of their tissue chromium after 28 wk depuration. Evidence is presented which suggests that oysters would be a better indicator of chromium pollution of the environment than mussels. (Author's abstract)
W84-04899

CHEMICAL AND THERMAL LOADS OF THE DANUBE AND ITS TRIBUTARIES (UBER CHEMISCHE UND THERMISCHE BELASTUNGEN DER DONAU UND IHRER NEBENFLUSSE),

Bulgarian Academy of Sciences, Sofia. Inst. of Hydrology and Meteorology.
K. I. Sofia.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 181-193, 1982. 2 Fig, 2 Tab, 27 Ref.

Descriptors: *Danube River, *Chemical wastes, *Thermal pollution, *Water quality management, *Water quality standards, Water pollution prevention, Water pollution control, Water management, Water use, Industrial wastes, Water pollution sources.

The Danube and its tributaries must increasingly support demographic growth, new plant discharges and increased water demand. As a whole, the tributaries which are abundant in water and the rather large riparian towns bring but local changes in the degree of the load that must be supported by the Danube water. The situation regarding dissolved oxygen has clearly deteriorated on the whole course of the river. At high level, the dissolved oxygen content gradually sinks to 9-12 mg/l in the water of the upper reaches and to 5-8 mg/l in the lower reaches. Even higher and more dangerous is the proportion of mineral oils, biocides, heavy metals and radioactive waste products in the chemical pollution of the Danube. In the future, the thermal load will be just as important due to the intensive construction of thermonuclear plants on the shores of the Danube. In spite of the heavy load that has to be supported by the Danube this river can still be classified as a relatively clean body of water, thanks to its self-purifying and dilution capacity. In order to prevent the increase of the pollution of the Danube, some decisive and urgent decontamination measures should be taken and the industrial and municipal waste waters should be purified before entering the Danube and its tributaries. Such measures must include the construction of new waste water treatment plants and the restoration of older ones. It will also be necessary in the coming years to set up standardized specifications for the tolerable levels of pollution in river waters; such standards will have to be set up in international cooperation and will be binding for all the riparian states of the Danube. It will also be necessary to pass an international convention regarding the quality of the Danube water. What is needed is an alarm system on the whole course of the Danube which will report any accidental and disastrous case of pollution. The quality of the Danube water can only be attained through the cooperation of all the riparian states. (Murphy-IVI)
W84-04907

RADIOECOLOGICAL PROBLEMS IN THE DANUBE DRAINAGE AREA (RADIOOKOLOGISCHE PROBLEME IM DONAUEINZUGSGEBIET),

Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
K. Hubel.
Schweizersche Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 194-203, 1982. 11 Ref.

Descriptors: *Radioecology, *Danube River, *Drainage area, Radioactive wastes, Nuclear powerplants, Tritium, Strontium, Isotopic tracers, Radionuclides, Path of pollutants, Model studies.

In the Danube area there are nuclear plants with an electricity output of 2 GW, with anticipated increases well around six times greater by the end of the century. A model is described to track the main exposure paths of nuclear plant discharges in Europe. Special reference is made to the importance of marginal ecological conditions caused by the behavior of radionuclides in the aquatic biosphere. Mention is made of the possibilities of determining them from emission and immission measures. The radionuclide tritium has been tracked through the Danube and its tributaries. The gamma-spectrograph is used to analyze nuclides in water and in hydrobiological material to determine their concentration. The concentration of strontium isotopes is also determined. All the results are in the same order of magnitude. Part of the data regarding doses has also been calculated. (Murphy-IVI)
W84-04908

MERCURY ACCUMULATION BY FILAMENTOUS ALGAE: A PROMISING BIOLOGICAL MONITORING SYSTEM FOR METHYL MERCURY IN ACID-STRESSED LAKES,

Toronto Univ. (Ontario). Inst. for Environmental Studies.
P. M. Stokes, S. I. Dreier, M. O. Farkas, and R. A. N. McLean.
Environmental Pollution (Series B), Vol. 5, No. 4, p 255-271, 1983. 1 Fig, 5 Tab, 31 Ref.

Descriptors: *Bioindicators, *Bioaccumulation, *Aquatic plants, *Algae, *Methyl mercury, *Acidic water, Water pollution effects, Hydrogen ion concentration, Monitoring.

One of the potential effects of lake acidification is related to the demonstrated negative correlation between mercury in fish and pH of lake water. To date, this relationship has not been shown for other aquatic biota. The present study was designed to determine total and methyl mercury in filamentous green algae collected from natural and artificial substrates in eleven lakes (pH 4.5-7.2) on the Precambrian Shield of south-central Ontario. When grown on artificial substrates, these algae, which are abundant in acid-stressed sites, showed considerable promise as monitors of mercury. Intra-site variation in mercury content was low and inter-site differences were significant. The mercury was almost entirely methyl mercury. In contrast, mercury in algae from natural substrates showed more variation and lower proportions of methyl mercury. The mercury content of the algae showed no relationship to mercury in the sediment or water, but was of the same magnitude as, and significantly correlated with, mercury in the flesh of yearling perch collected from the same acid-stressed lakes three years previously. In the fish study, a strong inverse relationship was observed between the mercury content of the perch and the pH of the water. The results indicate that the uptake of methyl mercury into both fish and algae may be primarily determined by the availability of methyl mercury in water. The algae show promise as a

cheap and rapid method for monitoring methyl mercury availability in acid-stressed lakes. (Author's abstract)
W84-04941

DIHALOACETONITRILES IN DRINKING WATER: ALGAE AND FULVIC ACID AS PRECURSORS,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
B. G. Oliver.
Environmental Science and Technology, Vol. 17, No. 2, p 80-83, February, 1983. 1 Fig, 2 Tab, 18 Ref.

Descriptors: *Drinking water, *Organic compounds, *Dihaloacetonitriles, Fulvic acid, Algae, Water treatment, Chlorination, Water pollution sources, Scenedesmus, Anabaena.

Chlorinated drinking water samples from 10 locations in southern Ontario were found to contain dihaloacetonitriles, DHAN's. All samples contained CHCl2CN (ranging from 0.3 to 8.1 ppb) and some contained CHBrClCN (ranging from not detectable to 1.8 ppb). The average molar DHAN concentration was about 10% of the average molar trihalomethane concentration. The concentration of dihaloacetonitriles found in several southern Ontario water supplies can be produced by chlorinating aquatic humic substances and algae under the conditions used for water treatment. Of the two algae species tested, the blue-green Anabaena Texas 1447, which had a much higher organic nitrogen content, produced considerable more DHAN's on chlorination than the green Scenedesmus basiliensis. (Baker-IVI)
W84-04943

THERMAL AND METABOLIC FACTORS AFFECTING PCB UPTAKE BY ADULT BROWN TROUT,
Argonne National Lab., IL. Radiological and Environmental Research Div.
For primary bibliographic entry see Field 5C.
W84-04944

EFFECT OF NUTRIENTS ON THE RATES OF MINERALIZATION OF TRACE CONCENTRATIONS OF PHENOL AND P-NITROPHENOL,
Cornell Univ., Ithaca, NY. Lab. of Soil Microbiology.
H. E. Rubin, and M. Alexander.
Environmental Science and Technology, Vol. 17, No. 2, p 104-107, February, 1983. 3 Fig, 4 Tab, 13 Ref.

Descriptors: *Mineralization, *Phenol, *Nitrophenol, *Nutrients, *Trace levels, Nutrient requirements, Arginine, Yeast, Water properties, Chemical properties.

The rates of phenol mineralization in samples of three lakes were directly proportional to concentration at phenol levels of 2.0 pg/mL to 200 ng/mL. The rate at any one concentration was related to the trophic level of the water. In samples containing microbial cells collected from the eutrophic lake, reducing the nutrient supply decreased the mineralization rate. Inorganic nutrients, arginine, or yeast extract often enhanced but glucose reduced the rate of mineralization. Arginine was not stimulatory in stream water. Mineralization was slower than predicted at phenol concentrations of 1.5 pg/mL or less but occurred at predicted rates in the presence of arginine. Arginine also stimulated the mineralization of 19-197 pg of p-nitrophenol/mL by lake water microorganisms, but only at one p-nitrophenol concentration was it stimulatory in stream water. Organic and inorganic nutrients in natural waters affect the rate of mineralization of organic compounds in trace concentrations. (Murphy-IVI)
W84-04945

NITROGEN SOURCE EFFECT ON NITRATE AND AMMONIUM LEACHING AND RUNOFF LOSSES FROM GREENS,
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
K. W. Brown, J. C. Thomas, and R. L. Duble.
Agronomy Journal, Vol. 74, No. 6, p 947-950, November-December, 1982. 5 Fig, 1 Tab, 15 Ref.

Descriptors: *Leaching, *Water pollution sources, *Golf courses, *Nitrates, *Ammonium, Infiltration rate, Fertilizers, Runoff, Milorganite, Ureaformaldehyde, Isobutylenediurea, Ammonium nitrate, Soil types.

The use of sandy rooting media with rapid infiltration rates in the construction of golf greens provides the potential for N pollution of nearby water supplies. This study was designed to measure the effects of different N sources on NO3(-) and NH4(+) concentrations in leachate and runoff from golf greens constructed with various rooting media. Individual golf greens with USGA-type profiles were constructed in the field with upper 30 cm layers consisting of sand-peat, sand-soil-peat and sandy loam soil mixtures. All profiles were equipped with subsurface tile drains over a plastic sheet and were treated sequentially with the following N fertilizers: NH4NO4, ureaformaldehyde, 12-12-12, Milorganite, and IBDU. Leachate and runoff were collected and analyzed for NO3(-) and NH4(+). Nitrate concentrations in leachate from sand, mixed, and soil greens fertilized with quick release materials ranged from 45 to 326, 8 to 314 and 8 to 170 mg/liter, respectively and remained in this range for a 3-week period. Runoff concentrations from the greens constructed of sandy loam soil exceeded 30 mg/liter. No runoff was collected from sand or mixed greens. Nitrate N losses from various sources were in the order of NH4NO3 > 12-12-12 > Milorganite > isobutylenediurea (IBDU) > ureaformaldehyde. Isobutylenediurea provided a very uniform release rate. Milorganite had a 25 to 30 day delay before NO3(-) appeared in the leachate. Soluble sources, NH4NO3, and 12-12-12 exhibited leaching within 5 days after application. It appears that regular moderate applications of slow release N sources would provide minimum NO3(-) loss while supplying a continuous N supply. Ammonium losses ranked from greatest to smallest were NH4NO3 > Ureaformaldehyde > Milorganite > 12-12-12 > IBDU. Ammonium losses contributed very little to the total N losses from golf greens. Highest total N loss was 23% of the applied N. (Author's abstract)
W84-04994

CHEMICAL CHARACTERISTICS OF SURFACE RUNOFF FROM SOILS AND REVEGETATED LIGNITE MINE SPOILS,
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
K. W. Brown, J. C. Thomas, and L. E. Deuel, Jr.
Journal of Soil and Water Conservation, Vol. 39, No. 2, p 146-149, March-April, 1984. 4 Fig, 1 Tab, 9 Ref. BM grant J0295016.

Descriptors: *Spoil banks, *Texas, *Water pollution sources, *Land reclamation, Surface runoff, Topsoil, Lignite, Water quality, Revegetation, Storm runoff, Hydrogen ion concentration, Conductivity, Iron, Manganese.

Surface runoff from three revegetated lignite mine spoils and nine native soils on three geological deposits along the Texas Gulf Coast were evaluated. Purpose was to compare water quality from revegetated, nontopsoiled spoils with that from undisturbed soils. Field plots 4.6 x 9.5 m x 10 m deep were established on revegetated, nontopsoiled test pits at each geological deposit and on three soils representative of each of the three areas to be mined. Stormwater runoff from natural rainfall events was sampled following major storms and analyzed for pH, electrical conductivity (EC), soluble Fe, and Mn. Although runoff water pH from revegetated spoil on the Jackson deposit was low initially, a slow increase occurred during the first 15 months after revegetation. Runoff pH from spoils was eventually similar to that from soils. Runoff water pH from revegetated spoil on the other two geological deposits was similar to that from the soil during the first 15 months after revegetation. EC of runoff water from revegetated spoil was less than 3 dS/m for all sites immediately after revegetation and declined to background levels within 1 year. Concentrations of Fe in runoff exceeded 3.5 mg/l during the first 6 months following revegetation; however, later concentrations were similar to those from soils. The Fe concentration in runoff from the Jackson deposit spoil and topsoils was low, but the concentration from spoil increased slightly with time. The concentration of soluble Mn in runoff was initially greater than 2.0 mg/l from revegetated spoil on the Jackson and Claiborne deposits but declined to background levels after 4 months. Initially, EC and soluble Fe and Mn concentrations in runoff from revegetated spoil on several of the deposits studied were greater than desirable. However, they reached concentrations comparable to those in runoff from adjacent soils within 4 to 15 months after the initial phases of revegetation. (Author's abstract)
W84-05057

DISTRIBUTION OF ALKYL LEAD SPECIES IN THE MERSEY ESTUARY,
Liverpool Univ. (England). Dept. of Oceanography.
J. P. Riley, and J. V. Towner.
Marine Pollution Bulletin, Vol. 15, No. 4, p 153-158, April, 1984. 10 Fig, 1 Tab, 18 Ref.

Descriptors: *Alkyl lead compounds, *Mersey Estuary, *Manchester Ship Canal, *England, Lead, Estuaries, Water pollution sources, Tetra-alkyl lead, Industrial wastes, Lead compounds.

The Mersey is unique among British estuaries in receiving the waste from a plant producing tetra-alkyl lead as an anti-knock ingredient for gasoline. The effluent is discharged continuously at Ellesmere Port into the Manchester Ship Canal. Differential pulse anodic stripping voltammetry was used to study the distribution of dissolved inorganic lead, and di- and tri-alkyl lead species in the Mersey Estuary and the Manchester Ship Canal. The concentration of total alkyl lead in the Manchester Ship Canal decreased for the high value of 4.7 x 10 to the -7 mol/l near the effluent discharge to less than one-twelfth of this value at the Weaver sluices. At all stations seawards of the point of discharge into the estuary the total concentration of alkyl lead was 5-10 times that of dissolved inorganic lead. In general, di-alkyl lead constituted about one-tenth of the total alkyl lead. The total alkyl lead concentration behaves conservatively in the estuary, in line with the stability and low adsorbability of these compounds. In contrast, inorganic lead shows a strongly non-conservative behavior. Concentrations of total alkyl lead in the Ship Canal are much higher than those in the estuary. (Moore-IVI)
W84-05080

COAL MINE DRAINAGE IN THE UNITED STATES - AN OVERVIEW,
Pennsylvania State Univ., University Park. Coll. of Earth and Mineral Sciences.
H. L. Lovell.
Water Science and Technology, Vol. 15, No. 2, p 1-25, 1983. 5 Fig, 5 Tab, 60 Ref.

Descriptors: *Mine drainage, *Water pollution control, *Coal mining, Water quality control, Acidity, Wastewater treatment, Pyrite oxidation, Bacteria, Permits, Legal aspects, Legislation.

The mining of coal disturbs the near surface strata to modify geohydrology and enhances the opportunities for pyrite to oxidize forming water soluble acidic compounds. Laws and complex regulations of the Federal and State governments, functioning through a permit system, require specific planning and operations to achieve minimum environmental change. The permit system involves pre-mine planning, bonding, inspection, enforcement and prompt reclamation. By maintaining an alkaline environment, seeking isolation of the reactive components, and applying numerous specialized mining practices their effects on water quantity and quality variation can be substantially controlled. Only when unavoidable conditions exist must degraded waters be treated to avoid ecological changes in receiving streams and hydrologic systems. Control

approaches to minimize changes in water quantity and quality have evolved in the past two decades by law regulation, industry coordination, and research. Preventive control is sought rather than practice treatment to meet effluent guidelines for minimum quality. A tonnage production fee funds restoration of pre-law abandoned mine conditions. The bases of control are: hydrologic budget maintenance, sedimentation to reduce particle transport and suspended solids, evaluate strata alkalinity and sulfide content, and maintenance of an alkaline strata environment for sulfide stability. (Baker-IVI)
W84-05086

REVIEW OF WATER POLLUTION PROBLEMS AND CONTROL STRATEGIES IN THE SOUTH AFRICAN MINING INDUSTRY,
J. O. Kempe.
Water Science and Technology, Vol. 15, No. 2, p 27-58, 1983. 7 Fig, 9 Tab, 19 Ref.

Descriptors: *Water quality control, *Water pollution control, *South Africa, Review, Salinity, Legislation, Effluents, Water conservation, Industrial wastes, Water reuse, Wastewater treatment, Mining.

South Africa's exploitable water resources are limited, and these resources are being seriously polluted in some areas, notably in the Vaal River catchment. During winter months and periods of drought mineral salt loads in the Vaal Barrage catchment have already reached critical peaks for certain industrial uses. It is becoming increasingly important to take both short term and long term action in order to safeguard water supplies and preserve their quality. Strict application of statutory and regulatory tools are insufficient in themselves to have the desired effect. Maintaining increases in industrial cooperation is essential to achieve required goals. A number of individual striking achievements of effluent recycle, water conservation and effluent purification, particularly among larger industries have been made, but it is necessary for industry as a whole, no matter how small the use of water, to review critically its water and effluent management. Positive action from all quarters has become an urgent necessity for the protection of the limited water resouces of the country. Special attention is given to the mining industry and its use of water and discharge of effluents in South Africa. (Baker-IVI)
W84-05087

MINE WATER POLLUTION - AN OVERVIEW OF PROBLEMS AND CONTROL STRATEGIES IN THE UNITED KINGDOM,
National Coal Board, London (England).
H. G. Glover.
Water Science and Technology, Vol. 15, No. 2, p 59-70, 1983. 1 Fig, 3 Tab, 4 Ref.

Descriptors: *Coal mining, *Water pollution control, *Great Britain, Water management, Surplus water, Water reuse, Salinity, Pyrite, Suspended sediments, Water quality control.

The management of water within the British coal mining industry and the means by which surplus waters are discharged to the environment without serious effect are described. The acquisition, use, treatment and re-use of water is detailed with particular emphasis placed on the control of the volume and quality of surplus water generated. The total average daily volumes of water involved in the British coal mining industry are illustrated. Water is acquired from rivers, streams, wells, boreholes, rainfall, and underground and opencast mine workings. Surplus water is generated during nine coal mining activities; baths, canteens and offices; steam-raising and cooling; coal preparation; underground mine drainage; spoil heaps; coal stock-piles; colliery surfaces and buildings; and abandoned mines. Treatment is used to reduce the salinity of coal mine surplus waters, remove the excessive concentrations of suspended mineral particles, and remove pyrite oxidation products. (Baker-IVI)
W84-05088

DEPOSITION OF ACIDIC COMPONENTS AND HEAVY METALS IN THE FEDERAL REPUBLIC OF GERMANY FOR THE PERIOD 1979-1981,
Frankfurt Univ. (Germany, F.R.). Inst. fuer Meteorologie und Geophysik.
H. W. Georgii, C. Perseke, and E. Rohbock.
Atmospheric Environment, Vol. 18, No. 3, p 581-589, 1984. 10 Fig, 1 Tab, 18 Ref.

Descriptors: *Deposition, *Heavy metals, *West Germany, *Acids, Aerosols, Fallout, Precipitation, Sulfates, Nitrates, Chlorides, Water pollution sources.

Measurements of wet and dry deposition of sulfate, nitrate, chloride and heavy metal aerosols were obtained from a network in the Federal Republic of Germany during 1979 to 1981. Wet deposition was the dominant sink-mechanism for the anions sulfate, nitrate and chloride as well as for the heavy metal-aerosols lead and cadmium which occur in the fine-particle mode. Only for heavy metal-aerosols in the size range above 1 micro m radius like Mn and Fe does dry deposition exceed wet deposition. In contrast to ambient sulfate and nitrate concentrations the spatial distribution of sulfate and nitrate concentration in rainwater is more homogeneous. The main fraction of acidifying anions in precipitation consists of sulfate (50-60%) with the contribution of nitrate amounting to 25-30%. Wet deposition-pattern of acidifying anions in remote areas is mainly determined by the rainfall pattern. Wet deposition rate of sulfate and nitrate is higher during summer than during winter. The trace substance concentration in rainwater decreases during the course of individual cases of rainfall. Highest concentrations are observed at the onset of rainfall. (Baker-IVI)
W84-05093

PCB UPTAKE AND TRANSFER TO HUMANS BY LAKE TROUT,
Michigan Univ., Ann Arbor. School of Natural Resources.
A. L. Jensen.
Environmental Pollution (Series A), Vol. 34, No. 1, p 73-82, 1984. 5 Fig, 13 Ref.

Descriptors: *Polychlorinated biphenyls, *Path of pollutants, *Trout, *Fishing, Mathematical models, Mortality, Lake Michigan, Public health, Foods.

A mathematical model for contaminant uptake from food and water by fishes is combined with a model for yield as a function of fishing mortality in order to examine both the contaminant concentration in fishes and the amount of contaminant transferred to humans from fishes as functions of fishing mortality. The models are fitted to lake trout Salvelinus namaycush data from Lake Michigan, where there has been a persistent problem of PCB contamination. Transfer of contaminants from fishes to humans can be regulated through control of fishing. The concentration of contaminant decreases exponentially as fishing mortality increases because fishing reduces the number of older individuals in the population and concentration is a function of age. The amount of contaminant transferred from a fish population to humans increases to a maximum and then begins to decrease as fishing effort increases. The maximum rate of transfer occurs at a relatively low level of fishing. (Author's abstract)
W84-05094

MAJOR PROCEDURAL DISCREPANCIES IN SOIL EXTRACTED NITRATE LEVELS AND NITROGEN ISOTOPIC VALUES,
Nebraska Univ.-Lincoln. Inst. of Agriculture and Natural Resources.
C. W. Lindau, and R. F. Spalding.
Ground Water, Vol. 22, No 3, May-June, 1984. 4 Fig, 1 Tab, 23 Ref.

Descriptors: *Groundwater pollution, *Nitrates, *Vadose water, *Nebraska, Nitrogen, Path of pollutants, Nitrogen radioisotopes, Leaching.

Samples were collected from an area encompassing 144 sq miles of Gage, Saline, and Jefferson counties in southeastern Nebraska. Most of the study area received about 28 inches of precipitation and is composed of flat-lying plains dissected by river and creek valleys. The preliminary data from the five cores indicated that the concentrations of extractable NO3-N and delta-N-15 values are influenced by the volume of extractant (2N KCl). Use of the 1:1 ratio results in underestimating the available NO3-N for leaching through the vadose zone and a probable misinterpretation of the sources of nitrate contamination. More study is needed to determine whether extractable nitrate concentrations and nitrogen isotopic values are influenced by changes in soil properties and by the type of extractant used. It appears logical that samples very high in nitrate necessitate soil-to-extractant (2N CKl) ratios equal to or greater than 1:10, while ratios of 1:5 may be sufficient for samples low in nitrate. (Baker-IVI)
W84-05102

MATRIX DIFFUSION EFFECTS ON CONTAMINANT MIGRATION FROM AN INJECTION WELL IN FRACTURED SANDSTONE,
Golder Associates, Mississauga (Ontario).
S. Feenstra, J. A. Cherry, E. A. Sudicky, and Z. Haq.
Ground Water, Vol. 22, No. 3, p 307-316, May-June, 1984. 8 Fig, 16 Ref.

Descriptors: *Injection wells, *Path of pollutants, *Sandstone, Waste disposal, Mine wastes, Groundwater pollution, Mathematical models.

Deep-well injection into fractured sandstone is an option for the disposal of contaminated mine dewatering discharge from an open pit uranium mine. As part of the assessment of potential contaminant migration from deep well injection, the effect of matrix diffusion was evaluated. The range of effective diffusion coefficients for intact cores of sandstone from boreholes in the vicinity of the proposed injection well studied encompassed samples that exhibited considerable differences in apparent texture and degree of induration. Measured values of the matrix porosity of sandstone samples averaged 9%. An analytical mathematical model was developed for the simulation of the radial movement of contaminants away from an injection point in a single planar fracture with uniform properties. Entry of contaminants into the matrix as a result of diffusion provides a much larger surface area for adsorption than would otherwise be the case in the absence of matrix diffusion. The results of the study are favorable to the concept of short term disposal of contaminated water in the fractured sandstone formation. The main uncertainty in the predictions rests with the inability of the simplified model to account for the spatial variability in both the fracture and matrix properties within the injection zone. (Baker-IVI)
W84-05106

DISTRIBUTION OF NITROGENOUS COMPOUNDS IN A RHODIC PALEUDULT FOLLOWING HEAVY MANURE APPLICATION,
North Carolina State Univ. at Raleigh.
J. R. Cooper, R. B. Reneau, Jr., W. Kroontje, and G. D. Jones.
Journal of Environmental Quality, Vol. 13, No. 2, p 189-193, April-June, 1984. 3 Fig, 2 Tab, 22 Ref.

Descriptors: *Manure, *Nitrogen, *Water pollution sources, *Groundwater pollution, Nitrates, Nitrites, Ammonia, Leaching, Fertilizers, Decomposition, Path of pollutants.

Agriculture faces the problem of animal manure disposal while maintaining crop yields and soil water quality. There is an economic advantage of manure disposal at elevated rates close to the source. This in turn increases the potential for groundwater contamination. This study was conducted to determine the effect of high rates of cattle and poultry manure application on the N balance and on the distribution of NH4(+), NO3(-), NO2(-), and total N to a depth of 6 m in a Davidson clay loam soil (Rhodic Paleudult, clayey, kaolinitic, thermic). Average dry weights of manure added per year (from 1972 to 1976) were 32, 61, and 121 Mg/ha for cattle and 94 and 184 Mg/ha for poultry waste. In addition to

manure treatments, a fertilizer treatment and a control were also present. A N balance showed that while 36% of the inorganic fertilizer N applied was removed by the crop, with manure application < 10% of the total was crop recovered. The percentage of the total N in the upper 6 m of the soil profile generally decreased with increased manure N application, although N present increased with increased N applications. The unrecovered N, attributed primarily to denitrification losses, increased with increased N application and ranged from 6% for the fertilizer check to 58% for the highest rate of poultry manure. The primary inorganic N component in the soil profile was NO3(-)-N and the zone of maximum accumulation is between 2 and 2.5 m. The organic N fractions remaining in the soil profile could be adequately estimated using existing decay constants. The present study shows that the most feasible means of determining the quantity of manure to apply for crop growth and simultaneously reduced N leaching would be the use of decay series for manure decomposition combined with an estimate of atmospheric loss. (Author's abstract)
W84-05113

EFFECTS OF FOREST CLEARCUTTING IN NEW ENGLAND ON STREAM CHEMISTRY,
Northeastern Forest Experiment Station, Durham, NH.
C. W. Martin, D. S. Noel, and C. A. Federer.
Journal of Environmental Quality, Vol. 13, No. 2, p 204-210, April-June, 1984. 10 Fig, 1 Tab, 14 Ref.

Descriptors: *Water pollution sources, *Clear-cutting, *Stream pollution, Environmental effects, Watershed management, Forest management, Logging, Nitrogen, Calcium, Water chemistry.

Differences in stream chemistry between recently clearcut and nearby uncut watersheds were generally small in a wide variety of soil and forest types throughout New England. Water samples were collected during six periods of the year in 1978 and 1979 from 6 entirely clearcut, 32 partially clearcut, and 18 uncut watersheds. The largest differences that could be attributed to harvesting occurred in entirely clearcut watersheds, especially in the White Mountains of New Hampshire. In one area of the White Mountains, inorganic N was 4 times higher (2 mg/L), and Ca was 2 times higher (4 mg/L) in streams from a clearcut watershed than in a nearby uncut watershed. Elsewhere, only minor changes in stream chemistry resulted from cutting; the amount of the cutting response was of the same magnitude as natural variations among streams draining similar watersheds. Clearcutting less than entire watersheds, patch and strip cuts, and buffer strips along streams all appear to reduce the magnitude of changes in stream chemistry. (Author's abstract)
W84-05114

POTENTIAL AQUIFER POLLUTION FROM NITRATE LEACHING FOLLOWING THE PLOWING OF TEMPORARY GRASSLAND,
Lincoln Coll. (New Zealand). Dept. of Soil Science.
K. C. Cameron, and A. Wild.
Journal of Environmental Quality, Vol. 13, No. 2, p 274-278, April-June, 1984. 2 Fig, 3 Tab, 14 Ref.

Descriptors: *Nitrates, *Leaching, *Plowing, *Groundwater pollution, *England, Water pollution sources, Grasslands, Soil solution, Mineralization, Chalk soils.

Investigation of the amounts and concentrations of nitrate released following the plowing of temporary grassland confirmed that this practice forms a potential major source of NO3-N pollution of aquifers. Estimates were made of the amounts and concentrations of NO3(-) released due to mineralization following the fall plowing of temporary grassland at three sites on Chalk soils, and the rate of leaching of this NO3-N by winter rainfall. Large amounts of NO3(-) (100 kg N/ha) are released due to fall mineralization and the amount appears to be related to the soil total N content rather than age of the temporary grass. At two sites, losses of NO3(-) due to winter leaching to depths below the 90-cm depth were about 100 kg N/ha over two winters and about 25 kg n/ha over one winter at the third site. High concentrations of NO3(-) in soil solution, in excess of WHO limits, are found to move out of the soil into the unsaturated zones of the Chalk aquifers. The average rate of leaching through the Chalk soils studied in southern England was about 1 m/yr. It is recommended that winter rather than spring cereals be planted after temporary grass and that the crop be planted as soon as possible in order to minimize the leaching loss of NO3(-). (Moore-IVI)
W84-05120

NITRATE LEACHING AS INFLUENCED BY WATER APPLICATION LEVEL AND NITRIFICATION INHIBITORS,
Agricultural Research Service, Ames, IA.
For primary bibliographic entry see Field 5G.
W84-05122

PEAK NITRATE-NITROGEN VALUES IN SURFACE RUNOFF FROM FERTILIZED PASTURES,
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
L. B. Owens, W. M. Edwards, and R. W. VanKeuren.
Journal of Environmental Quality, Vol. 13, No. 2, p 310-312, April-June, 1984. 1 Fig, 3 Tab, 13 Ref. EPA grant R-804631.

Descriptors: *Pastures, *Nitrates, *Fertilizers, *Water pollution sources, *Ohio, Grazing, Animal wastes, Agricultural runoff, Surface runoff.

Pastured watersheds on hill slopes in eastern Ohio were fertilized with ammonium nitrate (NH4NO3) at two different levels for 5 years. The pastures were rotationally grazed during either the growing season (May-October) or the dormant season (November-April). Nitrate-N concentrations were measured in surface runoff events > 0.1 mm from nine watersheds. During the 5-year period, there were 890 runoff events. Sixty-four of these events (7%) had NO3-N concentrations > 10 mg/L, and 48 of the 64 events occurred within a 30-day period following fertilizer application. Ten events, < 2% of all of the runoff events, exceeded 30 mg/L NO3-N, and all of these were within 17 day of fertilization. Although all surface runoff events which closely followed fertilizer applications did not have high NO3-N concentrations, all surface runoff with high NO3-N was shortly preceded with a fertilizer application. The closeness of the high NO3-N concentration and fertilizations suggested that fertilizer was the major contributor to high NO3-N in runoff as opposed to animal waste. (Author's abstract)
W84-05123

SIMULATION OF WATER POLLUTION GENERATION AND ABATEMENT ON SUBURBAN WATERSHEDS,
Washington Univ., Seattle. Coll. of Engineering.
B. Glenne.
Water Resources Bulletin, Vol. 20, No. 2, p 211-217, April, 1984. 2 Fig, 4 Tab, 12 Ref.

Descriptors: *Watershed management, *Simulation, *Water pollution sources, *Salt Lake City, *Utah, Coliforms, Bacteria, Suspended solids, Water quality control, Assimilative capacity, Computers.

Computer simulation and model calibration of three suburban watersheds near Salt Lake City, Utah, indicate that coliform bacteria and suspended solids are produced mainly by the presence of people, domestic animals, vehicles, disposal systems, and other constructed facilities. The importance of each of these activities is investigated and pollution abatement procedures are outlined for purposes of improved watershed management. Water quality simulation for a watershed integrates several quite approximate methods in hydrology, environmental engineering, and urban planning. Numerical results should be regarded in this light. Of primary interest is the focus provided by the technique on existing cause and effect pollution relationships in the given watershed. In particular, the simulation technique lends itself to mapping of pollution sources and identification of activities which generate stream pollution. By modifying the existing situations in the model the effects of proposed developments or suggested abatement procedures may be roughly anticipated. The technique can also be used to estimate assimilative capacities of watersheds and streams. (Baker-IVI)
W84-05160

TRACE ELEMENTS IN NORTHERN GREAT PLAINS STRIP MINE AND LIVESTOCK IMPOUNDMENT WATER,
Siskiyou National Forest, Grants Pass, OR.
M. T. Anderson, and C. L. Hawkes.
Water Resources Bulletin, Vol. 20, No. 2, p 251-254, April, 1984. 1 Fig, 3 Tab, 20 Ref. EPA grant EPA-IAG-D-5-E764.

Descriptors: *Trace elements, *Strip mines, *Livestock ponds, *North Dakota, *South Dakota, *Wyoming, Coal, Bentonite, Cadmium, Lead, Manganese, Iron, Heavy metals.

The water from 32 strip mine water impoundments and nine livestock watering ponds in North Dakota, South Dakota, and Wyoming were analyzed for trace elements. Because of the high concentrations of trace elements in coal and bentonite clay, the possibility exists for these elements to dissolve or be suspended in the water. Strip mine ponds were not significantly higher in trace elements concentrations compared to livestock ponds. All but one of the 41 ponds sampled contained elemental concentrations that would be detrimental for livestock use or aquatic life use. Cadmium and lead were the elements most frequently in excess of water quality criteria. Lead was found in the study ponds about 35 times the median concentration of North American rivers. Manganese concentrations were found to exceed iron in many ponds, which is unusual in natural waters. The potential for detrimental concentrations of trace elements in pond water must be evaluated when designing land use management plans for ponds intended to be used by livestock or aquatic life. (Author's abstract)
W84-05166

HEAVY METALS IN ESTUARINE SHELLFISH FROM OREGON,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
R. S. Caldwell, and D. R. Buhler.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 15-23, January, 1983. 1 Fig, 6 Tab, 30 Ref. NIH grants ES-00040 and ES-00210, Oregon State Univ. Sea Grant College Program grant 04-3-158-4.

Descriptors: *Shellfish, *Heavy metals, *Oregon, Estuarine environment, Mollusks, Crustaceans, Cadmium, Cockles, Clams, Crab, Seasonal variation, Water pollution sources.

In order to provide a baseline for mean metal concentrations and seasonal variability, concentrations of Hg, Zn, Mn, Fe, Cu, and Cd were determined in marine shellfish from the Oregon coast. Recreationally important shellfish, including cockles, softshell clams and Dungeness crab were collected quarterly in 1972 from estuaries. Additional samples were obtained on an irregular basis in 1970, 1971, and 1974. Other molluscan and crustacean species were collected irregularly during 1971 and 1972. Heavy metal levels in both crustaceans and molluscs were generally typical of those reported from other geographic areas. The primary exception was Cd, which in crustaceans was 5 to 40 times lower and in three of the six marine bivalve molluscs studied was 5 to 25 times lower than that found in most previous studies. The low concentrations of Cd may be due to the lower level and types of industrial activity in coastal Oregon estuaries compared to other regions of the world, and/or to a lower rate of input of this metal from natural weathering processes in this region. No significant variations due either to season or

geographical location were apparent in the three principal shellfish species studied. (Moore-IVI)
W84-05170

LEAD ELIMINATION AND SIZE EFFECTS ON ACCUMULATION BY TWO FRESHWATER GASTROPODS,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
M. C. Newman, and A. W. McIntosh.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 25-29, January, 1983. 2 Fig, 1 Tab, 8 Ref. Contract DE-AC09-76-SR00-H19.

Descriptors: *Gastropods, *Lead, *Fate of pollutants, Elimination, Physiology, Heavy metals, Body size.

Freshwater gastropods, Physa integra and Campeloma decisum, inhabiting a small reservoir with elevated levels of lead displayed widely differing soft tissue lead concentrations. Analysis of environmental factors did not fully explain these differences. Several physiological characteristics of the two gastropods were examined. The influence of snail size on concentrations of naturally-accrued lead was examined as was the rate of lead elimination from the two species. Lead concentrations in P. integra were independent of animal size, while those of C. decisum were described by the curvilinear model: micro g Pb/g dry wt = 2.29(g dry wt)-0.25. Naturally-accrued lead in P. integra was eliminated rapidly during the first four days of clearance but slowly thereafter; a portion of the lead is apparently bound strongly. In contrast, no significant change in lead concentration of gravid or nongravid C. decisum occurred during a three to four week period in which the animals were maintained in a lead-free environment. (Author's abstract)
W84-05171

SYNTHETIC MUSK RESIDUES IN BIOTA AND WATER FROM TAMA RIVER AND TOKYO BAY (JAPAN),
Tokyo Metropolitan Research Lab. of Public Health (Japan). Dept. of Food Hygiene and Nutrition.
T. Yamagishi, T. Miyazaki, S. Horii, and K. Akiyama.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 83-89, January, 1983. 2 Fig, 9 Tab, 13 Ref.

Descriptors: *Musk xylene, *Musk ketone, *Tama River, *Tokyo Bay, *Japan, Wastewater pollution, Shellfish, Fish, Fate of pollutants, Bioaccumulation, Herbicides.

The synthetic musks musk xylene and musk ketone are used in soaps, detergents, creams and lotions as natural musk substitutes. Musk ketone is also used in commercial herbicide formulations. Musk xylene and musk ketone were detected in 100% and 80%, respectively of 74 samples: freshwater fish (three species); marine shellfish (four species); river water, and wastewater (three sewage treatment plants). The samples were collected from several sampling stations along the Tama River, a dam, and Tokyo Bay, during July and October, 1980 and 1981. The average concentrations of musk xylene were 53.9 ppb in the viscera of freshwater fish, 16.0 ppb in the fish muscle, and 2.7 ppb in marine shellfish; the mean levels of musk ketone were 30.5 ppb in the viscera, 7.8 ppb in the muscle, and 1.6 ppb in the shellfish. The mean levels in river water were 4.1 ppt for musk xylene and 9.9 ppt for musk ketone, but no detectable levels of musk ketone were found in freshwater fish and river water upstream of the Tama River and the dam. The highest concentrations of both compounds were observed in freshwater fish downstream, and the highest concentrations in water samples were found in wastewater from the sewage treatment plants, situated along the banks of the river. Both compounds exist as bioaccumulation-type pollutants in the aquatic ecosystem. The contamination by musk xylene and musk ketone was probably due to domestic wastewater. (Moore-IVI)
W84-05174

DISPOSITION OF 2,4-DICHLOROPHENOXYACETIC ACID IN RAINBOW TROUT,
Washington Univ., Seattle. Dept. of Environmental Health.
L. A. Carpenter, and D. L. Eaton.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 169-173, March, 1983. 4 Fig, 1 Tab, 15 Ref.

Descriptors: *Trout, *Dichlorophenoxyacetic acid, Herbicides, Excretion, Fish, Fate of pollutants, Half life.

This study investigated the dynamics of 2,4-dichlorophenoxyacetic acid (2,4-D) in Salmonid fish. Similar to mammals and marine fish, trout excrete 2,4-D via the urine, with an elimination half-life of 2.4 hr. Although the amount of 2,4-D found in bile was always less than 1% of the dose, the concentration of 2,4-D in bile was greater than any other tissue or fluid four hr or more after exposure. From 20 to 96 hr following administration, bile was the only tissue or fluid which contained detectable amounts of 2,4-D. The results demonstrate that rainbow trout eliminate 2,4-D very rapidly via urinary excretion. However, detectable levels of 2,4-D may be found in the bile for many hours after it is eliminated from all other tissues. (Author's abstract)
W84-05179

POLYCHLOROBIPHENYL FLUX IN PLANKTONIC MODEL ECOSYSTEMS,
Canada Centre for Inland Waters, Burlington (Ontario).
E. S. Millard, C. C. Charlton, and G. A. Burnison.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 203-210, March, 1983. 6 Fig, 3 Tab, 15 Ref.

Descriptors: *Polychlorinated biphenyls, *Plankton, *Path of pollutants, Ecosystems, Clay, Particulates, Sedimentation, Organic carbon, Biomass, Volatilization, Algae.

Polychlorobiphenyl (PCB, Aroclor 1242) loadings of 2.12, 21.5 and 212 micro g/d were added to three model planktonic ecosystems. Each loading consisted of a clay and water mixture in which 92% of the PCB was adsorbed to the clay particles. After addition, partitioning between soluble and particulate pools in the water and sedimentation of PCB was examined. Particulate PCB concentrations were positively related to changes in particulate organic carbon (POC) indicating a transfer of PCB from clay to the algal community. The percent of the total PCB concentration measured as soluble was inversely related to POC. The proportion of PCB added to each column that was sedimented, not recovered or remained in the water column was similar at all loading rates. Approximately one-half of the PCB added was not accounted for in sedimentation or the water and was assumed lost by volatilization. High algal biomass and sedimentation of organic matter reduced this loss. (Author's abstract)
W84-05182

NATURE OF CADMIUM BINDING IN COMMERCIAL EASTERN OYSTERS (CRASSOSTREA VIRGINICA),
National Marine Fisheries Service, Charleston, SC. Charleston Lab.
T. C. Siewicki, J. C. Sydlowski, and E. S. Webb.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 3, p 299-304, May, 1983. 4 Fig, 17 Ref.

Descriptors: *Oysters, *Cadmium, *Scallops, Foods, Public health, Zinc, Copper, Metal binding, Metallothionein, Proteins.

The eastern oyster (Crassostrea virginica) is the only mollusk representing a significant food item contributing substantial Cd to the total body burden of consumers. Since the chemical form of ingested Cd may influence its availability or toxicity to the consumer, it is important to determine its form in order to assess its overall risk to human health. The forms of cadmium occurring in 'natural' commercially available oysters were partially characterized. About one-third of the Cd was associated with insoluble material. About 20% of the soluble Cd occurred in a high molecular weight protein of 40,000-50,000 daltons. The low molecular weight soluble Cd consisted of at least two different forms, i.e., that associated with amino acids (a small peptide) and inorganic Cd. The small peptide fraction also contained zinc and copper. The forms of Cd in commercial oysters were compared to those occurring in both commercial scallops and artificially cultured oysters. Scallops bind Cd to three soluble proteins, all of which are of higher molecular weight than the small oyster peptide. Oysters cultured in 10 ppb Cd medium contained binding sites similar to commercial oysters except that none of the soluble Cd in the cultured oysters was associated with a high molecular weight protein. Extremely high environmental Cd levels may be necessary to induce a metallothionein-like protein in oysters. Upon eventual determination of the actual biological availability and toxicity of the various forms of Cd in nature, this data can be used to estimate the potential toxicity of Cd in oysters. (Moore-IVI)
W84-05184

ESTIMATION AND VERIFICATION OF THE ENVIRONMENT FATE OF O-BENZYL-P-CHLOROPHENOL,
Monsanto Co., St. Louis, MO.
A. F. Werner, T. A. Taulli, P. R. Michael, and M. A. Williams.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 4, p 569-575, September, 1983. 4 Fig, 5 Tab, 11 Ref.

Descriptors: *O-Benzyl-p-chlorophenol, *Disinfectants, *Fate of pollutants, Chlorinated phenols, Biodegradation, Municipal wastewater, Wastewater treatment, Bioaccumulation, Photolysis.

O-Benzyl-p-chlorophenol (OBPC) has widespread use in the United States as a hospital phenolic disinfectant; annual production averages less than 4,500,000 kg. Disposal is primarily via municipal waste treatment where biodegradation removes 95% of the OBPC as confirmed by modeling and field measurements. Measured influent and effluent concentrations from 16 sites in the United States averaged 14.8 micro g/L and 0.8 micro g/L, respectively. These measured data confirm the utility of the Holman model (in Aquatic Toxicology and Hazard Assessment: Fourth Conference. ASTM STP 737, 1981) for predicting the concentration of household chemicals during sewage treatment. OBPC is apparently rapidly metabolized by fish and has a low potential to bioconcentrate in biota (bioconcentration factor for OBPC is 75). Based upon laboratory studies, biodegradation and photolysis are the major transformation processes in the environment; hydrolysis and volatilization rates are insignificant. The five percent of the total OBPC reaching the aquatic environment was predicted by two models to partition to the water column resulting in an average surface water concentrations of 0.001-0.008 micro g/L. Environmental sampling at 18 sites in the eastern United States confirmed that the average concentration in surface waters was < 0.11 micro g/L. (Author's abstract)
W84-05191

CHEMICAL AND BIOLOGICAL INDICATORS OF FLUORIDE INPUT IN THE MARINE ENVIRONMENT NEAR AN INDUSTRIAL SOURCE (ARGENTINA),
Aluar Aluminio Argentino, Chubut.
J. O. Ares, A. Villa, and A. M. Gayoso.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 5, p 589-602, September, 1983. 7 Fig, 4 Tab, 48 Ref.

Descriptors: *Smelters, *Aluminum, *Fluorides, *Argentina, Marine environment, Air pollution, Water pollution sources, Diatoms, Wind, Soil erosion, Wind erosion, Precipitation.

Changes in fluoride concentrations in neritic waters near an aluminum smelter in southern Ar-

gentina are attributable to fluoride emissions from industrial operations. Winds from the source vary in importance as pollutant carriers depending on the timing of precipitation events which wet the soil and diminish its erodability. Emissions account for 2 to 6% of the variance of fluoride levels in nearby waters. Some structural changes in the diatom community were detected during these studies, and they were correlated in various ways with fluoride levels. The pattern of these correlations do not support the hypothesis that fluoride changes of the magnitude observed have an effect upon these organisms, but rather than diatoms and fluoride adsorbed on small particles are transported along similar turbulent regimes within neritic waters. The added input of fluoride to the marine environment will probably not alter the balance of this chemical in nearby waters, and the magnitude of the changes observed has not produced changes in the observed planktonic organisms. (Author's abstract)
W84-05192

POLYBROMINATED ANISOLES IN MARINE FISH, SHELLFISH, AND SEDIMENTS IN JAPAN,
Osaka Prefecture Inst. of Public Health (Japan).
I. Watanabe, T. Kashimoto, and R. Tatsukawa.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 615-620, November, 1983. 4 Fig, 2 Tab, 11 Ref.

Descriptors: *Polybrominated anisoles, *Fate of pollutants, *Marine environment, *Fish, *Shellfish, *Japan, Marine sediments, Water pollution sources, Dibromoanisole, Tribromoanisole, Pentabromoanisole, Fire retardants, Anisoles, Chlorination, Wastewater treatment.

Polybrominated anisole (2,4-dibromoanisole, 2,4,6-tribromoanisole and pentabromoanisole) concentrations were determined in marine fish, shellfish, and sediments collected in Japan. 2,4,6-Tribromoanisole was found in fourteen of 24 fish and shellfish samples, with a range of 0.1-5.4 micro g/kg (ppb) on a wet weight basis. The concentrations of 2,4,6-tribromoanisole were similar to pentachloroanisole and hexachlorobenzene but about one-hundredth of those of polychlorinated biphenyls. The correlation between 2,4,6-tribromoanisole and polychlorinated biphenyls levels in fish and shellfish samples was statistically significant. 2,4-Dibromoanisole was found in four fish samples, with a range of 0.6-1.3 ppb. Pentabromoanisole was not found in any samples of fish and shellfish. No polybrominated anisoles were detected in the sediment samples. 2,4-Dibromoanisole and 2,4,6-tribromoanisole have not been manufactured for any industrial uses in Japan. The sources of 2,4-dibromoanisole and 2,4,6-tribromoanisole may be the corresponding phenols. Possible sources of 2,4,6-tribromophenol include the chlorination of wastewater and seawater, and the decomposition of flame retardants; 2,4-dibromophenol may be a decomposition product from 2,4,6-tribromophenol. (Moore-IVI)
W84-05193

SEDIMENTARY CHEMISTRY OF A SMALL POLLUTED LAKE, GALLTRASK, S. FINLAND,
Helsinki Univ. (Finland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W84-05228

TRANSVERSE MIXING IN PHYSICAL MODEL EXPERIMENTS (TURBULENTE QUERVERMISCHUNG IN AUSBREITUNGS-MODELLVERSUCHEN),
Karlsruhe Univ. (Germany, F.R.).
G. Webel, and M. Schatzmann.
Wasserwirtschaft, Vol. 73, No. 5, p 137-142, May, 1983. 6 Fig, 17 Ref.

Descriptors: *Mixing coefficient, *Hydrologic models, *Model studies, *Laboratory models, Path of pollutants, Cooling water, Dispersants, Hydraulic gradient, Parametric hydrology, Waste-assimilative capacity, Wastewater dilution, Wastewater outfall, Assimilative capacity.

After introducing a dimensionless transverse mixing coefficient as similarity criterion for physical modeling of waste-water or cooling-water dispersion in rivers, an experimental study to investigate the dependence of this similarity number on river parameters was carried out. Instructions for setting-up a laboratory dispersion experiments are described. The water should have a 3 cm minimum depth for the model to develop effective results. The mixing coefficient is of the first order in turbulent flow in a stream. (Murphy-IVI)
W84-05240

MIXING PROCESSES PAST OUTFALL DISCHARGES IN STREAMS (AUSBREITUNG BEI EINLEITUNGEN IN STROMUNGEN),
E. Naudascher, and L. Fink.
Wasserwirtschaft, Vol. 73, No. 11, p 369-379, November, 1983. 28 Fig, 25 Ref.

Descriptors: *Discharge hydrographs, *Discharge measurement, *Discharge coefficient, *Flow discharge, Stage-discharge relations, Mixing, Open channels.

Mixing processes near the discharge area and downstream are illustrated through numerical and graphical analysis. The experiments were carried out both in water and air tunnels. Their goal was to expand our knowledge on turbulent dispersion phenomena and to yield a basis for the development of computational methods. In particular, the effect of outfall-discharge and mainstream parameters were investigated for round coaxial and transverse jets, for jets with swirl and pulsation, as well as for lateral discharges into open channels. Application of the results is illustrated with selected examples. (Murphy-IVI)
W84-05255

NUMERICAL CALCULATION OF TURBULENT TRANSPORT PROCESSES IN WATER BODIES (NUMERISCHE BERECHNUNG TURBULENTER AUSBREITUNGSBORGANGE IN GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
W. Rodi.
Wasserwirtschaft, Vol. 73, No. 11, p 401-410, November, 1983. 14 Fig, 26 Ref.

Descriptors: *Mathematical models, *Turbulent flow, *Flow characteristics, Differential equations, Mathematical analysis.

The development at the SFB 80 of field methods for the numerical calculation of turbulent transport processes in water bodies is summarized. The methods are based on the differential equations describing the flow and pollutant concentration field and simulate the turbulent exchange processes with the aid of various versions of the fairly universal k-(epsilon) turbulence model. Computational efficiency is achieved by employing the model chain concept, which subdivides the total solution domain into individual regimes for which the simplest possible model component is used. The wide applicability of the methods is demonstrated by a number of calculation examples. (Murphy-IVI)
W84-05257

INTEGRAL MODELS FOR BUOYANT PLUME CALCULATIONS (INTEGRALVERFAHREN ZUR BERECHUNG VON AUFTRIEBSSTRAHLEN),
Hamburg Univ. (Germany, F.R.). Meteorology Inst.
M. Schatzmann.
Wasserwirtschaft, Vol. 73, No. 11, p 416-422, November, 1983. 12 Fig, 20 Ref.

Descriptors: *Integral models, *Plumes, *Model studies, *Flow characteristics, Jets, Wastewater disposal, Cooling water, Diffusion coefficient, Discharge coefficient, Discharge hydrographs.

Integral models have been proven to be successful and inexpensive tools for the solution of a variety of jet-type environmental flow problems. In the Sonderforschungsbereich 80, a family of integral models have been developed for several applications as, e.g., the mixing of waste water and cooling water plumes discharged into lakes and coastal waters or the dispersion of pollutants and heat emitted by chimneys, cooling towers and urban heat islands into the atmosphere. The common features of these integral models are discussed. The quality of the model results is demonstrated by comparing predictions with experimental data. (Murphy-IVI)
W84-05258

BIOLOGICAL REACTIONS IN WATERS (BIOLOGISCHE REAKTIONEN IN GEWASSERN),
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Ingenieurbiologie.
For primary bibliographic entry see Field 2H.
W84-05261

SHELL OF MYTILUS AS AN INDICATOR OF ZONAL VARIATIONS OF WATER QUALITY WITHIN AN ESTUARY,
Dundee Univ. (Scotland). Dept. of Geology.
M. A. M. Al-Dabbas, F. H. Hubbard, and J. McManus.
Estuarine, Coastal and Shelf Science, Vol. 18, No. 3, p 263-270, March, 1984. 1 Fig, 4 Tab, 25 Ref.

Descriptors: *Mytilus, *Shells, *Bioindicator, *Estuaries, *Water quality, Mineralogy, Chemical properties, Tay estuary, Aragonite, Bioaccumulation, Monitoring, Copper, Pollutant identification.

The mineralogy and chemistry of the shell material secreted by organisms can vary with the environment of growth. Variations in the mineralogy and chemistry of the shells of the filter-feeding organism Mytilus edulis have allowed discrimination of subenvironments of growth within the Tay estuary. Aragonite proportions higher than those predictable for the temperature, tidal, growth conditions are associated with stretches of the estuary affected by organic pollution. Accumulation and concentration of copper (Cu) in the organic periostracum suggest that Mytilus shell may also prove useful as a monitor of metallic element pollution. The relatively fragile nature of the polylayer shell of Mytilus and the layer specific distribution of components require the use of either complete, undamaged specimens or population groups to discriminate significant variations. (Murphy-IVI)
W84-05288

5C. Effects Of Pollution

ENVIRONMENTAL IMPACT OF NITRATE DISTRIBUTIONS IN THE LAKE-EFFLUENT CANAL SYSTEM IN KANDY, SRI LANKA,
Sri Lanka Univ., Peradeniya. Dept. of Geology.
S. V. R. Weerasooriya, A. Senaratne, and C. B. Dissanayake.
Journal of Environmental Management, Vol. 15, No. 3, p 239-250, October, 1982. 9 Fig, 1 Tab, 20 Ref.

Descriptors: *Environmental impact statement, *Nitrate, *Kandy, *Sri Lanka, Domestic wastes, Nitrification, Ions, Ammonium, Water quality, Water pollution effects, Water pollution.

Even though pollution from industrial effluents has not yet caused serious concern in Sri Lanka, pollution of ground water and drinking well water from biological sources has reached significantly high proportions during the last decade. The mid-canal of Kandy, Sri Lanka (an effluent canal running through the city and a large residential area) has been studied for its content of nitrogenous matter and its environmental impact on the surrounding residential area. The canal itself carries a very large load of nitrogenous waste matter, mainly from human and animal excreta. In spite of this, the NO3(-)-N and NH4(+)-N levels were low, indicating the existence of nitrogen in other forms. Water from wells situated near to the canal had higher concentrations of NO3(-)-N, indicating the possibility of nitrification and migration of the newly formed NO3(-)-N through the permeable alluvium. Because the potential for nitrification has

not been fully realized, and because a large number of families use these wells for washing, bathing, cooking, and in some cases for drinking, a serious health hazard can be envisaged in the future. (Murphy-IVI)
W84-04817

LONGEVITY OF ALGAL INHIBITION AFTER CHLORINATION OF ESTUARINE WATER,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 2L.
W84-04891

BEHAVIORAL RESPONSES OF A PHOXOCEPHALID AMPHIPOD TO ORGANIC ENRICHMENT AND TRACE METALS IN SEDIMENT,
Moss Landing Marine Labs., CA.
J. M. Oakden, J. S. Oliver, and A. R. Flegal.
Marine Ecology - Progress Series, Vol. 14, No. 2 and 3, p 253-257, January, 1984. 5 Tab, 24 Ref. EPA grant 808772-01.

Descriptors: *Behavior, *Phoxocephalid amphipod, *Trace metals, *Organic loading, Sediment composition, Food habits, Water pollution effects, Organic enrichment.

Marine bottom communities around large waste discharges often are highly modified, and characterized by the absence of certain groups of benthic invertebrates, particularly crustaceans and echinoderms. Phoxocephalid amphipods, Rhepoxynius spp., avoided sediments mixed with domestic sewage, or with concentrations of trace metals (zinc and cadmium) which are characteristic of marine sediments at waste-water discharge sites. The amphipods burrowed and swam from fine sands enriched with 15% sewage, and from sewage-contaminated sediment collected near the White's Point outfall in southern California, USA. They also suffered high (> 50%) mortality in sediment inoculated with high levels of zinc (610 micro g/g) or cadmium (190 micro g/g); swam and burrowed from sediments with high and moderate concentrations of either element; and burrowed from sediments with relatively low concentrations of either element. These responses indicate that behavioral avoidance of contaminated sediment may be important in maintaining population patterns of these phoxocephalids, which are often rare or conspicuously absent around large waste discharges. (Murphy-IVI)
W84-04901

THERMAL TOLERANCE IN EMBRYOS AND LARVAE OF THE BAY SCALLOP ARGOPECTEN IRRADIANS UNDER SIMULATED POWER PLANT ENTRAINMENT CONDITIONS,
Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.
D. A. Wright, W. H. Roosenburg, and M. Castagna.
Marine Ecology - Progress Series, Vol. 14, No. 2 and 3, p 269-273, January, 1984. 3 Fig, 4 Tab, 10 Ref.

Descriptors: *Thermal pollution, *Ecological effects, *Thermal tolerance, *Embryos, *Larvae, *Bay scallop, *Simulation, Cooling water, Lethal limit, Simulation analysis, Mortality.

Increasing demand for electricity has prompted the consideration of estuarine and marine coastal sites for both fossil fuel and nuclear power plants. This in turn has led to concern over the effects on marine and estuarine animals of heated water discharged from the condenser tubes and of heat exposure to entrained larvae. Thermal tolerance was tested in cleavage stages, trochophores and straight hinge larvae of the bay scallop Argopecten irradians. Experiments were designed to simulate larval entrainment in power plant cooling systems. An 11 (temperature) x 8 (time) matrix was used with temperatures ranging from 20.6 to 43.0 degrees C and exposure times from 1 min to 6 h. Pooled mortality data from triplicate experiments for each larval stage were subjected to stepwise regression analysis. Equations derived from these analyses, comprising first, second and third order terms for temperature and time, were used to generate response surfaces relating mortality to temperature and exposure time. In general, higher mortalities were associated with higher temperatures and with longer time exposure at any one temperature. However, there was some evidence of cold shock in trochophore and straight hinge larvae, with elevated mortalities occurring at temperatures lower than the spawning temperature. There was a trend towards increased thermal tolerance in older larvae, although in general A. irradians showed the greatest sensitivity to thermal shock of the estuarine bivalves so far tested in our laboratory. (Murphy-IVI)
W84-04902

DEVELOPMENT OF THE PHYTOPLANKTON AND PHYTOBENTHOS UNDER THE INFLUENCE OF WASTE WATERS (DIE ENTWICKLUNG DES PHYTOPLANKTONS UND DES PHYTOBENTHOS UNTER DEM EINFLUSS DER ABWASSER),
Osijek Univ. (Yugoslavia).
D. Gucunski.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 216-229, 1982. 15 Ref.

Descriptors: *Phytoplankton, *Phytobenthos, *Water pollution effects, *Wastewater, Behavior, Self-purification, Danube River, Aquatic productivity, Hydrobiology, Bacillariophyceae.

In the communities of phytoplankton and phytobenthos of all the profiles studied in the river basin of the Danube which was under the influence of waste waters, the bacillariophyceae dominated at all seasons. The species Stephenodiscus hantzschii Grun. (alphamesosaprobic indicator) was present in the plankton communities of all the profiles. Based on the available vegetal indicators, it was established that the investigated stretches of the Danube and its tributaries are, as a whole, part of the betamesosaprophytic zone. Comparison of the results of the hydrobiological investigations pursued over a length of years has shown that the phytoplankton production has increased over the last decades due to the eutrophication of the Danube. In all of the profiles examined, self-purification processes have taken place in which the microphytes and macrophytes played an important role. There where waste water purification plants are already operating, the water quality gradually improves; this, on the whole, has a positive effect on the development of the primary producers and on the biocenosis. It is our opinion that, in order to efficiently protect the ecosystem of the Danube and its tributaries, it will be necessary in the future to intensify the hydrobiological investigations which should be coordinated at the international level. (Murphy-IVI)
W84-04910

DEVELOPMENT OF THE ZOOPLANKTON AND ZOOBENTHOS UNDER THE INFLUENCE OF WASTE WATERS (DIE ENTWICKLUNG DES ZOOPLANKTONS UND - BENTHOS UNTER DEM EINFLUSS DES ABWASSERS),
Magyar Tudomanyos Akademia, Budapest. Station for Danube Research.
A. Bothar.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 230-242, 1982. 17 Ref.

Descriptors: *Water pollution effects, *Zooplankton, *Zoobenthos, Danube, Biological properties, Ecological effects, Self-purification, Reviews.

Based on sixteen short papers presented by experts from Rumania, Yugoslavia and Hungary, the author reports on the effects of waste waters on the zooplankton and zoobenthos of the Danube and its tributaries. The numerous themes treated in the papers are grouped according to the type of pollution and the various stages of organization. In the coming years, the Danube and its larger tributaries will be able to cope with the pollution thanks to their self-purifying capacity. The tributaries possessing a lesser self-purifying capacity will, owing to their shorter length and their weaker stability, react more sensitivity to pollution, so that their water quality will deteriorate in a higher degree; thus, they will become increasingly dangerous for the Danube. The side-arms and the dead-arms functionally form a unity with the Danube. Their pollution brings irreversible changes in the Danube which are then reinforced by the impounding reservoirs, especially due to the increase of the retention time of the water. (Murphy-IVI)
W84-04911

ANTHROPOGENIC EFFECTS ON THE FISH POPULATION (ANTHROPOGENE EINWIRKUNGEN AUF FISCHBESTANDE),
Galati Univ. (Romania).
N. Bacalbasa-Dobrovici.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 243-251, 1982. 7 Ref.

Descriptors: *Anthropogenic effects, *Fish, *Population dynamics, Population density, Ecological effects, Fish populations, Danube River, Chub, Perch, Pike, Population exposure, Pollution load.

In the last two decades, anthropogenic effects on fish have become more and more perceptible. Growth of some species, hematological characteristics, changes in the fish populations, and adaptation of fishery methods have been studied. The satisfying development of the bleak in the central zone of the Danube has continued; the greatest increase was observed during the first two years of their life. Warm water seems to be beneficial to their growth. The extremely large population can also be attributed to the very limited fishery. When the water is polluted, many young, unripe, red corpuscles were found in the genera Barbus and Leuciscus. In the upper basin of the Danube, many of the fish populating the inland water bodies were infested by the tape-worm genus Proteocephalus; the loss of weight was at least 20%. The reduction of the barbel catches during the last twelve years is found over the whole Hungarian part of the Danube; it is a consequence of pollution from the upper basin of this river. The histological analyses show that the gonads of bleak and chub attain maturity earlier and more quickly in the warmer parts of the Velika Morava than in the other parts of the river. In the impounding lakes Mostistea and Rasa built in the south of the Baragan plain for irrigation purposes, bream and perch-pike have become the main species; carp are regressing. Owing to the relative great depth of 7 m, the fishery has had to adapt to a difficult technique. (Murphy-IVI)
W84-04912

BIOLOGICAL AND BIOCHEMICAL CONTRIBUTIONS OF DETERMINATION AND EVALUATION OF WATER QUALITY (BIOLOGISCHE UND BIOCHEMISCHE BEITRAGE ZUR ERFASSUNG UND BEWERTUNG DER GEWASSERGUTE),
Forschungsinstitut fuer Wasserwirtschaft, Bratislava (Czechoslovakia).
J. Ardo.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 252-262, 1982. 16 Ref.

Descriptors: *Bioindicators, *Biochemistry, *Water quality, Danube River, Water pollution effects, Macrophytes, Plankton, Reviews.

Four themes are dealt with in the present review. For the assessment of water quality, the macrophytes (as an indicator of the degree of pollution) and ATP concentration (for quantification of the bacterial biomass) prove to be favorable methods. The influence of sewage on surface waters is exemplified as the influence of urban and industrial wastes upon the algal biomass assay (Biomassentiter), the microbial colonization, the complete biocenosis and the toxicological effects which ensue. As illustrations to the change of water quality along the river course, the nitrification's-oxygen-demand's share of the BSB5-total value and the periphyton biomass is given. In a further topic, information from the following areas are summarized: studies of the water quality in the Bavarian Danube, ciliate and crustacean communities in the

Hungarian Danube and the influence of its tributaries and the saprobial plankton community in the Rumanian Danube in addition to the statistical evaluation of water quality in this section. (Author's abstract)
W84-04913

ASSESSING THE EFFECTS OF WATER CONTAMINATION,
Johns Hopkins Univ., Baltimore, MD.
A. Wolman.
Civil Engineering, Vol. 54, No. 4, p 38-41, April, 1984. 2 Fig.

Descriptors: *Water supply, *Drinking water, *Water pollution effects, Water pollution control, Public health, Organic compounds, Water treatment, Human diseases, Wastewater treatment.

Findings of ill effects in humans who have used water contaminated with microbiological producers of infectious diseases or with inorganic chemicals are documented. Similar reports for waters contaminated with organic chemicals are much less exacting. However, there are certain policies for future preventative and remedial measures for the management of wastewaters and the protection of drinking water which become obvious from reviews of the results of exposure to impure waters. The recording of waterborne infectious diseases has a long history with typhoid, dysentery, cholera, and amoebic dysentery. Evidence is still accumulating that nitrates and nitrites may create ill human effects. Throughout the increased production of organic chemicals the demand for removing the organic residues from drinking water grew. Testing of all organics increased so as to determine whether they were harmful for human consumption. Even so, the significance of their health effects when present in drinking water has not been clearly identified in the last 10 years of legislative or regulatory debate. Among the technologies available to treat the water are air stripping and use of carbon columns to remove the impurities. Ideally, chemical processes should approach closed cycles as much as possible. (Baker-IVI)
W84-04923

MERCURY CONTAMINATION OF THE BELGIAN AVIFAUNA 1970-1981,
Vrije Univ., Brussels (Belgium). Lab. foor Ecotoxicologie.
K. Delbeke, C. Joiris, and G. Decadt.
Environmental Pollution (Series B), Vol. 7, No. 3, p 205-221, 1984. 2 Fig, 6 Tab, 32 Ref.

Descriptors: *Mercury, *Contamination, *Aquatic birds, Food habits, Diets, Water pollution effects, Toxicity, Bioaccumulation, Biomagnification, Fate of pollutants.

Two hundred birds found dead in Belgium between 1970 and 1981, and belonging to 30 species, were analyzed for total mercury contamination. The contamination of aquatic birds ranged between 0.11 and 35 micro g/g wet weight. For terrestrial birds, the extreme values were: not detectable and 14 micro g/g. In both cases, differences in diet can explain the differences in contamination. The order of diets associated with increasing mercury contamination for aquatic birds was invertebrates, zooplankton and garbage, and fish; and for terrestrial birds this consisted of plants, invertebrates, mammals and birds. For raptors and owls, this effect of diet includes geographical variations within species. A higher mercury contamination level in the winter and early spring was noted for two species of owls. For aquatic birds, the contamination of liver was higher than that of kidney, with ratios varying between 1.2 and 2.5. For terrestrial birds, the ratio was closer to 1. A few determinations were also made for muscle and heart, giving respectively 0.25 and 0.6 of the liver contamination. Among the birds analyzed for their liver contamination, 15% showed levels higher than 3 micro g/g and could have been affected in their reproduction; 3% had levels higher than 10 micro g/g, and could have died from mercury poisoning; and 6% showed an abnormally high liver:kidney ratio, which could reflect an acute intoxication. There exists a striking parallelism between the levels of mercury and of organochlorine residues (DDT) in birds of prey, suggesting the existence of common ecotoxicological mechanisms. (Author's abstract)
W84-04942

THERMAL AND METABOLIC FACTORS AFFECTING PCB UPTAKE BY ADULT BROWN TROUT,
Argonne National Lab., IL. Radiological and Environmental Research Div.
S. A. Spigarelli, M. M. Thommes, and W. Prepejchal.
Environmental Science and Technology, Vol. 17, No. 2, p 88-94, February, 1983. 4 Fig, 3 Tab, 31 Ref.

Descriptors: *Polyclorinated biphenyls, *Thermal stress, *Metabolism, *Brown trout, Bioaccumulation, Toxicity, Food habits, Diets, Water pollution effects, Fish behavior.

The accumulation of PCBs from natural food and water by adult brown trout, Salmo trutta, were compared under three temperature treatments: a diel temperature cycle simulating that selected by brown trout in thermal effluents; a constant 13 degrees C, the optimum constant temperature for brown trout growth; natural fluctuations in ambient inshore temperatures. Direct uptake from water accounted for approximately 10% of the uptake from food and water. Fish exposed to the diel cycle or the arhythmic ambient regime fed and grew as though they were acclimated to the maximum temperatures experienced and accumulated more PCBs than fish exposed to the constant 13 degrees C regime. Total food consumption or growth was the best correlate of PCB concentration in whole fish while lipid content of muscle was the best correlate of PCB concentration in muscle. PCB accumulation was affected by temperature magnitude and variation, because these factors controlled food consumption, growth and lipid content of brown trout. (Author's abstract)
W84-04944

EFFECTS OF ACID RAIN ON APPLE TREE PRODUCTIVITY AND FRUIT QUALITY,
New York State Agricultural Experiment Station, Geneva.
P. L. Forsline, R. C. Mussleman, W. J. Kender, and R. J. Dee.
Journal of the American Society of Horticultural Science, Vol. 108, No. 1, p 7-74, 1983. 1 Fig, 5 Tab, 29 Ref.

Descriptors: *Apples, *Acid rain, *Crop yield, Hydrogen ion concentration, Russetting, Simulation.

Mature 'McIntosh', 'Empire', and 'Golden Delicious' apple trees (Malus domestica Borkh.) were sprayed with simulated acid rain solutions in the pH range of 2.5 to 5.5 at full bloom in 1980 and in 1981. In 1981, weekly sprays were applied at pH 2.75 and pH 3.25. Necrotic lesions developed on apple petals at pH 2.5 with slight injury appearing at pH 3.0 and pH 3.5. Apple foliage had no acid rain lesions at any of the pH levels tested. Pollen germination was reduced at pH 2.5 in 'Empire'. Slight fruit set reduction at pH 2.5 was observed in 'McIntosh'. The incidence of russetting on 'Golden Delicious' fruits was ameliorated by the presence of rain-exclusion chambers but was not affected by acid rain. With season-long sprays at pH 2.75, there was a slight delay in maturity and lower weight of 'McIntosh' apples. Even at the lowest pH levels no detrimental effects of simulated acid rain were found on apple tree productivity and fruit quality when measured as fruit set, seed number per fruit, and fruit size and appearance. (Author's abstract)
W84-05068

OBSERVATIONS ON THE FISH POPULATIONS OF AN EAST COAST ESTUARY,
Southern Water Authority, Chatham (England). Kent Div.
J. R. Wharfe, S. R. Wilson, and R. A. Dines.
Marine Pollution Bulletin, Vol. 15, No. 4, p 133-136, April, 1984. 4 Fig, 11 Ref.

Descriptors: *Fish, *Estuaries, *Medway Estuary, *England, Seasonal distribution, Species diversity, Herring, Smelt, Water quality, Thames, Tidal effects.

The technique of sampling fish from power station cooling water intake screens has been used during a previous study of the Medway Estuary (England). Monthly samples were again collected from the cooling-water intake screens at Kingsnorth Power Station on the Medway Estuary between April 1981 and August 1983. A total of 26,372 fish, comprising 41 species, was recorded. The seasonal distribution of both species numbers and abundance of fish was similar to earlier studies. The community structure has altered in recent years, with the more frequent occurrence and increasing population size of smelt and herring. The change is largely attributed to improved water quality conditions in the tidal Thames and the subsequent recolonization by species of fish which were previously absent for many years. The confluence of the tidal Medway and the Thames Estuary ensures a flood-tide common to both systems. (Moore-IVI)
W84-05079

INFLUENCE OF TURBID INFLOWS ON VERTICAL DISTRIBUTION OF LARVAL SHAD AND FRESHWATER DRUM,
Oklahoma Univ., Kingston. Biological Station.
W. J. Matthews.
Transactions of the American Fisheries Society, Vol. 113, No. 2, p 192-198, March, 1984. 2 Fig, 33 Ref. Fish and Wildlife Service contracts 14-16-0009-81-023 and 14-16-0009-82-018.

Descriptors: *Fish behavior, *Drum, *Shad, *Larval growth stages, *Turbidity, *Lake Texoma, Zooplankton, Fish food, Reservoirs, Depth distribution, Population dynamics.

Reservoirs on river mainstreams are subject to periodic floods that typically increase turbidity. Lake Texoma (Oklahoma-Texas) is a 36,000 ha impoundment of the Red and Washita rivers. In many years, the reservoir receives floods near or during the spawning seasons for fishes. These inflows rapidly raise the water level as much as several meters and introduce highly turbid water from trubutaries. Behavior of larval shad Dorosoma spp. and freshwater drum Aplodinotus grunniens was altered by inflow of turbid water into Lake Texoma in two different years. During periods of increased turbidity, larval shad were concentrated in a reduced volume of water near the surface, and larval freshwater drum were distributed throughout the water column in contrast to their normal concentration near the bottom. In 1981 and 1982, greatest decline in abundance of larval shad came after zooplankton density fell below 100 per liter, and during or immediately following an extended period of high turbidity. Nutritional stress resulting from decline in zooplankton abundance and changes in larval-fish behavior during turbid conditions could be one important factor in population dynamics of shad in reservoirs. (Moore-IVI)
W84-05085

CONSEQUENCES OF OIL POLLUTION ON THE DECOMPOSITION OF VASCULAR PLANT LITTER IN FRESHWATER LAKES: PART 1- DECOMPOSITION RATES AND DISSOLVED OXYGEN UTILISATION,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
M. D. Werner, V. D. Adams, and V. A. Lamarra.
Environmental Pollution (Series A), Vol. 34, No. 1, p 83-100, 1984. 2 Fig, 8 Tab, 26 Ref. OWRT project B-187-Utah.

Descriptors: *Oil pollution, *Decomposition, *Dissolved oxygen, Aquatic plants, Biological oxygen demand, Wind, Oxidation, Litter.

The effects of two crude oils on the decomposition of two aquatic macrophytes within two oligotrophic lakes located in the Rocky Mountains of the Western United States were studied. Additionally, the biological oxygen demand placed on the lakes

due to crude oil was assessed. During the year of investigation, the crude oils reduced the rate and extent of litter decomposition of the plant litter in both lakes. However, the metabolic activity of the oil-exposed decomposer community was greater than, or equal to, that of unoiled controls. Differences in the degree of impact of oils between plant types and lakes are explained by factors such as the biochemical structure of the plants, the sediment type of the lakes and the degree of physical energy input (e.g. wind) to the lakes. Up to 4.8 times as much oxygen was required to oxidize oiled plant matter as that required to oxidize the same unoiled plant litter. (Author's abstract)
W84-05095

UPTAKE AND PHOTOSYNTHETIC INHIBITION BY ATRAZINE AND ITS DEGRADATION PRODUCTS ON FOUR SPECIES OF SUBMERGED VASCULAR PLANTS,
Maryland Univ., Cambridge. Horn Point Environmental Labs.
T. W. Jones, and L. Winchell.
Journal of Environmental Quality, Vol. 13, No. 2, p 243-247, April-June, 1984. 4 Fig, 3 Tab, 18 Ref.

Descriptors: *Atrazine, *Submerged plants, *Phytotoxicity, *Chesapeake Bay, Herbicides, Photosynthesis, Estuaries, Potamogeton, Ruppia, Myriophyllum, Zannichellia, Water pollution effects, Macrophytes.

The photosynthetic inhibitory effect of atrazine (2-chloro-4-ethyl-amino-6-isopropyl amino-1,3,5-triazine) and three of its major metabolites (deethylated, deisopropylated, and hydroxyatrazine) were determined for four species of submerged macrophytes: Potamogeton perfoliatus L., Ruppia maritima L., Myriophyllum spicatum L., and Zannichellia palustris L. The four species showed a similar response to varied dosages of the parent atrazine compound with an average 11 (concentration at which photosynthesis is inhibited by 1%) for the four species of 20 micro g/L and an average I50 (concentration at which photosynthesis is inhibited by 50%) for the four species of 95 micro g/L. The three major degradation metabolites of atrazine produced varying degrees of photosynthetic inhibition in the four species, but generally the order of toxicity was deethylated > deisopropylated > hydroxyatrazine with hydroxyatrazine causing an apparent stimulation of photosynthesis in several species. Of four species tested, Myriophyllum spicatum L. was the most resistant to atrazine and its metabolites. The magnitude of the actual uptake of the compounds (micro g compound/grams dry wt (gdw) plant) by the plants correlated closely with the photosynthetic inhibitory response, i.e., at the same concentration the uptake of atrazine > deethylated > deisopropylated > hydroxyatrazine. Considering that an extremely high environmental concentration (0.5 mg/L) of deethylated atrazine for an estuary only produced a photosynthetic inhibition of from 20 to 40% in four major species of submerged macrophytes, it is concluded that the degradation products of atrazine tested did not play a major role in the disappearance of the submerged vascular plants from the Chesapeake Bay. (Author's abstract)
W84-05118

PERCEIVED WATER QUALITY AND THE VALUE OF SEASONAL HOMES,
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
C. E. Young.
Water Resources Bulletin, Vol. 20, No. 2, p 163-166, April, 1984. 1 Tab, 9 Ref.

Descriptors: *Water pollution effects, *Property value, *St Albans Bay, *Vermont, *Lake Champaign, Water quality,.

St. Albans Bay is a large bay on Lake Champaign in northern Vermont. Recreational use of the bay has declined over time. A major reason for this decline is the deterioration in water quality. The impact of degraded water quality on the value of seasonal homes adjacent to St. Albans Bay is estimated using hedonic price functions. The value of properties located adjacent to the bay are depressed by about 20%, or $4,500 on average, compared with similar nearby properties on the larger but cleaner lake. Approximately 430 residential properties are located adjacent to St. Albans Bay. If the quality of water in the Bay were improved to a level perceived to be equivalent to the main lake, the total value of properties adjacent to the Bay would increase by about two million dollars. If the perceived improvement were only 50%, the water quality rating variable can be used to estimate the impact on property values. For a perceived improvement of 50%, the increase in property values would be $903,000. (Baker-IVI)
W84-05153

BEHAVIORAL RESPONSES TO TWO ESTUARINE FISH SPECIES SUBJECTED TO BIS (TRI-N-BUTYLTIN) OXIDE,
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
L. W. Hall, Jr., A. E. Pinkney, S. Zeger, D. T. Burton, and M. J. Lenkevich.
Water Resources Bulletin, Vol. 20, No. 2, p 235-239, April, 1984. 2 Fig, 17 Ref.

Descriptors: *Fish behavior, *Bis (tri-n-butyltin) oxide, Bass, Menhaden, Organotin compounds, Avoidance, Antifouling paints, Estuarine fish, Toxicity.

The objective of this investigation was to evaluate the avoidance responses of juvenile striped bass, Morone saxatilis and Atlantic menhaden, Brevoortia tyrannus to bis (tri-n-butyltin) oxide. An avoidance responses was exhibited by striped bass at a total organic tin concentration of 24.9 micro g/L. Atlantic menhaden exhibited avoidance to total organic tin concentrations of 5.5 micro g/L and greater. Atlantic menhaden are generally more sensitive to toxicants than striped bass; therefore, avoidance responses reported in this study are not surprising. It is highly likely that the concentrations of total organic tin that were avoided by the test species in this study were much higher than expected environmental concentrations. Ecologically significant hazards may occur due to potential effects that unperceived or non-avoided organotin concentrations may have on behavioral responses mediated by chemosensory systems. (Author's abstract)
W84-05164

EFFECTS OF CADMIUM ON YOLK UTILIZATION, GROWTH, AND SURVIVAL OF ATLANTIC SALMON ALEVINS AND NEWLY FEEDING FRY,
Department of Fisheries and Oceans, St. Andrews (New Brunswick).
R. H. Peterson, J. L. Metcalfe, and S. Ray.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 37-44, January, 1983. 7 Fig, 4 Tab, 19 Ref.

Descriptors: *Cadmium, *Toxicity, *Salmon, Growth, Immature growth stages, Alevins, Fry, Mortality, Water pollution effects.

Growth and the yolk-to-embryo gross conversion efficiencies were determined for Atlantic salmon (Salmo salar L.) alevins and fry reared under control conditions and at 0.2 and 2.0 ppb cadmium (Cd). Alevins reared at 2.0 ppb Cd grew more slowly than controls and alevins reared at 0.2 ppb. The size reduction was due primarily to reduction in yolk-conversion efficiency during the latter half of yolk absorption. The rate of yolk uptake was also reduced at 2.0 ppb Cd. Mortality of feeding fry reared up to one month at 2.0 ppb Cd was 80 to 90%. Fry previously reared in 2.0 ppb Cd as alevins experienced lower mortality than those introduced to Cd at start of feeding. Mortality was preceded by hyperactivity and convulsions; 30 to 60% of fry exposed to 2.0 ppb Cd developed cranial swellings. Growth of fry surviving 2.0 ppb Cd for one month was severely retarded. There were no adverse effects from 0.2 ppb Cd. (Author's abstract)
W84-05172

HUMAN ENVIRONMENTAL EXPOSURE TO TRICHLORO- AND TETRACHLOROETHYLENE FROM WATER AND AIR IN MILAN, ITALY,
Milan Univ. (Italy). Inst. of Hygiene.
G. Ziglio, G. M. Fara, G. Beltramelli, and F. Pregliasco.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 1, p 57-64, January, 1983. 12 Tab, 28 Ref.

Descriptors: *Trichloroethylene, *Tetrachloroethylene, *Drinking water, *Human, *Milan, *Italy, Air pollution, Municipal water, Chlorinated hydrocarbons, Groundwater pollution, Trichloroacetic acid.

Annual consumption of trichloro- (TRI) and tetrachloroethylene (PER) in the Milan city area is estimated to be between 1,500 and 2,000 tons. Improper use and disposal of TRI and PER for many years have led to a serious pollution of groundwater, which is used untreated by 1,750,000 inhabitants through the municipal aqueduct. Two separate sub-areas of the city were considered, namely zone A (TRI and PER concentrations: 80 and 20 micro g/L, respectively) and zone B (12 and 4 micro g/L). Trento, a 70,000 inhabitants towns of northern Italy, supplied with drinking water not contaminated with TRI and PER, was chosen as a control (zone C). Atmospheric levels of TRI and PER were also measured: TRI concentrations were similar in zones A and B (7.6 and 7.1 mg/cu m), but higher levels of PER were found in zone A (14.8 vs 9.5 micro g/cu m), where many dry-cleaning laundries are located. In human subjects from the three zones, the total exposure to TRI and PER was biologically evaluated by measuring the plasmatic level of their metabolite trichloroacetic acid (TCA). Median plasmatic TCA levels were 38.2 micro g/L in zone A, 19.0 in zone B and only 7.5 in the control zone. The observed differences were highly significant, and unrelated to sex, age, body weight, residence, and the amount of water consumption. (Author's abstract)
W84-05173

HEMATOLOGICAL DYSCRASIA IN TELEOSTS CHRONICALLY EXPOSED TO SELENIUM-LADEN EFFLUENT,
Texas Univ. at Austin. Dept. of Pharmacology.
E. M. B. Sorensen, and T. L. Bauer.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 135-141, March, 1983. 7 Fig, 1 Tab, 21 Ref.

Descriptors: *Sunfish, *Water pollution effects, *Selenium, *Texas, *Martin Lake, Toxicity, Effluents, Powerplants, Industrial wastewater, Hepatopancreas, Blood disorders, Fly ash, Sludge, Bottom ash, Lepomis.

Lepomis microlophus (redear sunfish) were collected from Martin Lake, an east Texas reservoir, as well as a reference lake 8 km upstream in the same drainage system. Martin Lake received aqueous selenium-laden effluent from electrical generator plant systems used to collect fly ash, scrubber sludge, and bottom ash; the reference lake received no such effluent (Texas Parks and Wildlife Department, unpublished report). Neutron activation analysis was used to monitor selenium levels in the hepatopancreas (i.e., the liver and associated, disseminated exocrine pancreas), which is one of the major organs used in monitoring selenium exposure. Fish collected from areas adjacent to the selenium-discharge sites in Martin Lake accumulated about 19.8 ppm in the hepatopancreas, compared to approximately 8.4 ppm for fish collected further from the discharge site. Reference redear sunfish accumulated normal levels of 1.8 ppm in the hepatopancreas. Hematological abnormalities were most severe for fish collected from areas adjacent to the selenium discharge site. These abnormalities included altered leukocyte distribution with elevated numbers of hemoblasts, reduced hematocrits, lower hemoglobin concentrations, slightly reduced numbers of erythrocytes, 12% and 23% reductions in mean corpuscular hemoglobin concentration (MCHC) and mean corpuscular volume (MCV), respectively, and microcytic, poikilocytic erythrocytes with elevated numbers of nuclear shadows. These data present a striking

illustration of a case in which the hematological characteristics of a freshwater teleost were correlated with selenium accumulation in a critical organ following chronic selenium exposure. Hematological data provided a sensitive indicator of the severity of the impact of selenium-laden generator plant effluent on this teleost species. (Author's abstract)
W84-05177

EFFECTS OF ACIDIFIED WATER ON THE LOCOMOTOR BEHAVIOR OF THE GULF KILLIFISH, FUNDULUS GRANDIS: A TIME SERIES APPROACH,
Florida State Univ., Tallahassee. Dept. of Oceanography.
R. B. MacFarlane, and R. J. Livingston.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 163-168, March, 1983. 2 Fig, 3 Tab, 20 Ref. NOAA grant 04-3-158-43.

Descriptors: *Fish behavior, *Water pollution effects, *Killifish, *Acidic water, Hydrogen ion concentration, Locomotor activity, Physiological stress, Toxicity.

Behavioral responses can be an indicator of well-being under particular environmental conditions. In order to study the impact of acidification of natural aquatic systems on ecological processes, the locomotor response of fish to reduced pH was determined in Fundulus grandis, a euryhaline teleost commonly occurring in northern Gulf of Mexico estuaries. Locomotor activity of F. grandis was monitored hourly at four pH levels (7.8, 6.5, 5.0, and 4.0) for 96 hr using infrared photoelectric detection. As an internal control, the activity pattern of each fish was followed for 96 hr in pH 7.8 prior to acidification. Rhythmicity of activity patterns was progressively reduced with increased acidification. Fish became hyperactive in low pH water, particularly during the normal diurnal inactive period in pH 5.0 and 4.0. Time series analysis allowed quantitative determination of the effects of acidity on the normal diel activity pattern and suggested a useful method for detection of subtle changes in an activity regime in response to stress. In fish exposed to pH 5.0 and 4.0, there was increased secretion of mucus, changes in pigmentation, buoyancy and orientation control problems, and increased coughing. (Moore-IVI)
W84-05178

TOXICITY, BIOCONCENTRATION, AND METABOLISM OF THE HERBICIDE PROPANIL (3',4'-DICHLOROPROPIONANILIDE) IN FRESHWATER FISH,
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
D. J. Call, L. T. Brooke, R. J. Kent, M. L. Knuth, and C. Anderson.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 175-182, March, 1983. 3 Fig, 1 Tab, 56 Ref. EPA grant R-880020-01-0.

Descriptors: *Propanil, *Toxicity, *Fish, *Bioaccumulation, Metabolism, Herbicides, Mortality, Minnows, Trout, Growth stages.

Fathead minnows (Pimephales promelas) were exposed to technical grade propanil (3',4'-dichloropropionanilide) in a flow-through diluter system to determine acute lethality. LC50 values were 11.5, 10.2, 8.6, and 3.4 mg/L at 24, 48, 96, and 192 hr, respectively. Eggs, newly hatched fry, and juvenile fish of this species were similarly exposed but at lower concentrations and for a period of 58 days. The 58-day 'no effect' concentration was between 0.4 and 0.6 micro g/L, based upon the physiological parameters of length and dry weight of juvenile fish. C-14-Propanil did not bioconcentrate significantly in fathead minnows (1.6 x for parent propanil in whole body). Rainbow trout (Salmo gairdneri) readily metabolized propanil, forming at least ten products. One metabolite recovered from trout bile was identified as either 3',4'-dichloro-2-hydroxypropionanilide or 3',4'-dichloro-3-hydroxy-propionanilide. The technical grade propanil also contained 0.67 mg.g-1 of 3,3',4,4'-tetrachloroazo-benzene as a contaminant. (Author's abstract)
W84-05180

RESPONSES OF CHANNEL CATFISH TO XENOBIOTICS: INDUCTION AND PARTIAL CHARACTERIZATION OF A MIXED FUNCTION OXYGENASE,
Oklahoma State Univ., Stillwater. Dept. of Physiological Sciences.
S. W. Fingerman, L. A. Brown, M. Lynn, and E. C. Short, Jr.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 195-201, March, 1983. 4 Fig, 1 Tab, 42 Ref.

Descriptors: *Catfish, *Benzo(a)pyrene, *Mixed function oxygenase, Phenobarbital, Water temperature, Hydrogen ion concentration, Water pollution effects, Enzyme induction.

The effects of the environmental pollutant benzo(a)pyrene (BP) were assessed on the hepatic mixed function oxygenase system (MFO) in the channel catfish, Ictalurus punctatus. Initially, the optimum conditions were established for measuring hepatic MFO in this species of fish. Parameters investigated were divalent metal ion requirement, in vitro incubation temperature for optimum activity, pH for optimum activity and the time course for enzyme induction. A single dose of BP (100 micro g/kg body weight) given intraperitoneally to catfish kept in the laboratory at 19 degrees C induced the hepatic MFO benzo(a)pyrene hydroxylase (BaPH) with maximum activity occurring 96 hr after the injection of BP. Cytochrome P450 assays were carried out at 24 hr and 48 hr after injection of BP. Hepatic cytochrome P450 and BaPH activity increased from 24 to 48 hr after the BP injection. In a temperature acclimation experiment, fish were maintained at 15 degrees, 19 degrees, and 26 degrees C; assays for BaPH were conducted 24, 48, and 96 hr after an inoculation with BP. Induction occurred equally in all BP-injected fish by 24 hr; by 48 hr, induction was greatest in the fish kept at 26 degrees C, least in the 15 degrees C group. The fish kept at 19 degrees C were intermediate. However, by 96 hr, induction had occurred to the same degree in all three experimental groups. BaPH activity was always greater in the BP-injected groups than in their respective control groups. Phenobarbital (75 mg/kg body weight) failed to cause an increase in hepatic dealkylating activities or cytochrome P450 concentration. (Author's abstract)
W84-05181

TEMPORAL ACCUMULATION OF ORGANOCHLORINE PESTICIDES IN SHOREBIRDS WINTERING ON THE SOUTH TEXAS COAST, 1979-80,
Patuxent Wildlife Research Center, Victoria, TX. Gulf Coast Field Station.
D. H. White, C. A. Mitchell, and T. E. Kaiser.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 2, p 241-245, March, 1983. 1 Fig, 2 Tab, 13 Ref.

Descriptors: *Organochlorine pesticides, *Texas, *Birds, Agricultural runoff, DDE, Dieldrin, Toxaphene, Dowitchers, Avocets, Sandpipers, Pesticide residues, DDT, Shorebirds, Drainage.

Organochlorine pesticide residues were determined in 168 shorebirds of three species collected at approximate bimonthly intervals during the fall and winter months of 1979-80 near Port Mansfield on the south Texas coast. The study was conducted to determine if shorebirds wintering on mudflats at the outlets of agricultural drains in Texas accumulated pesticides during this period. The predominant organochlorine residues detected in shorebirds were DDE, dieldrin, and toxaphene. Ninety-five percent of the skinned carcasses analyzed contained detectable levels of DDE, 13% contained dieldrin, and 22% contained toxaphene. DDE significantly increased in all species of shorebirds from October to December, with potentially dangerous levels accumulating in some long-billed dowitchers (Limnodromus scolopaceus) and American avocets (Recurvirostra americana), but DDE residues seldom exceeded 0.5 ppm in carcasses of western sandpipers (Calidris mauri). After about two months on the study area, no further residue increases were documented. The high levels of DDE detected in a large proportion of the dowitchers, and to a lesser extent in the avocets, are near or within the range known to inhibit reproduction in some avian species. This study demonstrates that certain aquatic areas near agricultural lands on the south Texas coast may be potential threats to waterbirds eight years after the use of DDT was banned in the United States. (Author's abstract)
W84-05183

PETROLEUM HYDROCARBON CONCENTRATIONS IN A SALMONID STREAM CONTAMINATED BY OIL FIELD DISCHARGE WATER AND EFFECTS ON MACROBENTHOS,
Columbia National Fisheries Research Lab., Jackson, WY. Field Research Lab.-Jackson.
D. F. Woodward, and R. G. Riley.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 3, p 327-334, May, 1983. 3 Fig, 5 Tab, 21 Ref.

Descriptors: *Oil wastes, *Hydrocarbons, *Oil pollution, *Benthos, Water pollution effects, Effluents, Sediment pollution, Heavy metals, Plecoptera, Trichoptera, Diptera, Fisheries, Zinc.

The concentration of total hydrocarbons in the water effluent from an oil field was 5.6 mg/L and resulted in concentrations of 46 to 85 micro g/L in the receiving stream. Total hydrocarbons were 55,000 times more concentrated in the sediment than in the water, ranging from 979 (778) to 2,515 (1,263) mg/kg. Saturated hydrocarbons contributed most to the total hydrocarbon concentration in both water and sediment. Naphthalenes were found in stream water, but not in sediment. Cadmium, chromium, copper, lead, and zinc were detected in water and sediment. Zinc was elevated in the sediment, probably because an organic zinc complex was used by the oil company during processing to enhance oil-water separation. Species diversity of macrobenthos was reduced below the discharge, as evidenced by the almost complete elimination of Plecoptera and Trichoptera. Shannon-Weaver diversity index values ranged from 3.4 at the upstream control station to 1.2 to 1.7 below the oil field effluent. The representation of Diptera increased from 10% of the total insects at the least polluted station to 46% at the station containing the most dissolved hydrocarbons. On the basis of the findings, discharge of oil into fresh water should be closely regulated to prevent the development of concentrations in water and sediment of the receiving stream that would alter the structure of macrobenthos communities and thereby threaten the fishery resources. (Author's abstract)
W84-05185

SELENITE TOXICITY AND MERCURY-SELENIUM INTERACTIONS IN JUVENILE FISH,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
J. F. Klaverkamp, D. A. Hodgins, and A. Lutz.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 4, p 405-413, July, 1983. 4 Fig, 2 Tab, 73 Ref.

Descriptors: *Selenium, *Mercury, *Toxicity, *Fish, Juvenile growth stage, Mortality, Pike, Sucker, Perch, Heavy metals, Water pollution effects, Methyl mercury.

Selenium may have potential as a chemical amelioration measure in freshwater ecosystems contaminated by mercury. Acute lethal toxicities of selenium and the effects of selenium on mercury accumulation were determined in freshwater fish species. Selenite concentrations required to produce 50% mortality were approximately 11 mg Se/L in northern pike (Esox lucius), 29 mg Se/L in white sucker (Catostomus commersoni), and 5 mg Se/L in yellow perch (Perca flavescens) after 75, 96, and 240 hr of exposure, respectively. Two approaches were used to determine effects of water-borne sele-

nium on mercury concentrations in northern pike. A trend of reduced mercury contamination at a low selenium concentrations (1 micro g Se/L) with maintenance at control mercury contamination levels at a higher selenium concentration (100 micro g Se/L) was apparent in the first approach. A similar response of decreased CH3 Hg-203 accumulation in muscle-skin at lower selenium concentrations (1 and 10 micro g Se/L), but maintenance at control accumulation levels at a higher selenium concentration (100 micro g Se/L) was observed in the second approach. Selenium addition to mercury-contaminated freshwater ecosystems may have beneficial effects in reducing mercury concentrations in fish and other aquatic biota and in antagonizing mercury toxicity. (Moore-IVI)
W84-05186

JOINT TOXICITY OF MERCURY AND SELENIUM IN SALMONID EGGS,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
J. F. Klaverkamp, W. A. Macdonald, W. R. Lillie, and A. Lutz.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 4, p 415-419, July, 1983. 1 Fig, 4 Tab, 14 Ref.

Descriptors: *Trout, *Mercury, *Selenium, *Toxicity, *Fish eggs, Heavy metals, Water pollution effects, Mortality, Synergism.

Release of selenium and mercury to the atmosphere by industrial activities and subsequent deposition to the aquatic environment is resulting in gradual increases in contamination of freshwater ecosystems. While biological interaction between mercury and selenium generally result in decreased toxicity, a rare example of toxicity enhancement has been reported in carp eggs. Toxic interactions between mercury and selenium in fertilized eggs of rainbow trout (Salmo gairdneri) and lake trout (Salvelinus namaycush) were investigated under static conditions in polyethylene exposure containers. Mercury produced concentration-dependent decreases in median survival times and caused decreases in median hatch times. Selenium, at concentrations up to 10 mg Se/L, had no effect on hatching times, and did not produce mortality, and had no effect on mercury toxicity. At concentrations of 100 mg Se/L and higher, an apparent protective effect of selenium on mercury toxicity was observed in lake trout eggs. The marked synergistic effect between selenium and mercury was not observed in this study. (Moore-IVI)
W84-05187

FUNCTIONAL PROPERTIES OF A MICROCOSM OF THE FRESHWATER BENTHIC ZONE AND THE EFFECTS OF 2,4-DICHLOROPHENOL,
Argonne National Lab., IL. Radiological and Environmental Research Div.
P. A. Szczepanik-van Leeuwen, and W. R. Penrose.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 4, p 427-437, July, 1983. 10 Fig, 8 Tab, 15 Ref. Contract W-31-109-ENG-38.

Descriptors: *Microcosms, *Lake sediments, *Benthic environment, *Dichlorophenol, Decomposition, Carbon radioisotopes, Pontoporeia, Toxicity, Mortality, Organic carbon, Lake Michigan, Particulates.

A sediment-water microcosm system was evaluated that was designed to address some ecosystem functions selected a priori for their significance to man's use of lakes: (a) the decomposition of organic carbon, (b) secondary production, and (c) the binding or degradation of toxic chemicals. 2,4-Dichlorophenol (DCP) was chosen as a 'typical' toxic chemical. The microcosms were undisturbed cores recovered from a high-deposition area of Lake Michigan and dosed with a trace amount of C-14-alanine. The measurements found to be interpretable in terms of ecosystem functions were (a) turn-over of non-acid-volatile radiocarbon, (b) turnover of particulate radiocarbon, (c) rate of attachment of radiocarbon-labelled organisms to glass surfaces, (d) sediment penetration of radiocarbon, (e) mortality of benthic fauna (especially pontoporeia), and (f) toxicant concentrations. Lethal toxicity of DCP to Pontoporeia sp. in the microcosms agreed with that determined in controlled bioassays (96-hr LC50: 2.5 mg/L). Functions of the microbial community were initially inhibited by 81 mg/L DCP, but recovered in six days. The rates of radiocarbon turnover were reduced throughout the 21-day experiments even at the lowest concentration of DCP, 1.0 mg/L. These experiments have shown that a microcosm approach can yield quantitative estimates of the effects of toxicants on the functional properties of lake benthic ecosystems. (Author's abstract)
W84-05188

ACCUMULATION, SUBLETHAL EFFECTS, AND SAFE CONCENTRATION OF A REFINED OIL AS EVALUATED WITH CUTTHROAT TROUT,
Columbia National Fisheries Research Lab., Jackson, WY. Field Research Lab.-Jackson.
D. F. Woodward, R. G. Riley, and C. E. Smith.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 4, p 455-464, July, 1983. 7 Fig, 5 Tab, 25 Ref.

Descriptors: *Trout, *Toxicity, *Oil, Water pollution effects, Bioaccumulation, Oil pollution, Hydrocarbons, Naphthalenes, North Platte River, Wyoming.

Cutthroat trout (Salmo clarki) were exposed for 90 days in the laboratory to a refined oil collected from the North Platte River at a seepage site below the American Oil Company refinery at Casper, Wyoming. Fish were exposed to five concentrations and a control, and seven biological responses (survival, growth, gill pathology, liver pathology, caudal fin erosion, caudal fin pathology and swimming performance) were correlated with water concentration and tissue accumulation of petroleum hydrocarbons. Fish in the highest water concentration, 183 micro g/L total oil, accumulated tissue concentrations of 4.6 micro g/g total naphthalenes and responded adversely to all seven biological measurements. Cutthroat trout in the lowest water concentration, 24 micro g/L total oil, had a mean tissue concentration of 1.2 micro g/g total naphthalenes, but their response was similar to that of the control fish to all seven biological responses. Fish exposed to 39 micro g/L water concentration accumulated tissue concentrations of 2.7 micro g/g responded negatively to 2 of the 7 biological measurements. Therefore, the maximum safe limit for this oil and cutthroat trout is between 24 and 39 micro g/L. (Author's abstract)
W84-05189

UPTAKE OF LEAD FROM AQUATIC SEDIMENT BY SUBMERSED MACROPHYTES AND CRAYFISH,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
M. F. Knowlton, T. P. Boyle, and J. R. Jones.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 5, p 535-541, September, 1983. 1 Fig, 7 Tab, 17 Ref.

Descriptors: *Lead, *Aquatic plants, *Crayfish, *Sediment contamination, Water pollution effects, Submerged plants, Path of pollutants, Exoskeleton, Molting, Heavy metals.

Lead compounds and organic complexes are generally insoluble in natural waters so most Pb in contaminated aquatic ecosystems is found in the sediments. Macrophytes and crayfish are in physical contact with aquatic sediments and could serve as vectors in the transmission of Pb into food chains. Uptake of lead (Pb) by submersed aquatic macrophytes and crayfish exposed to artificially contaminated pond sediment was measured under laboratory conditions. Macrophytes accumulated Pb in root tissue and foliage. Concentrations in live foliage ranges from 5 to 89 micro g Pb/g compared with an average of 3 micro g Pb/g in uncontaminated plants. Internal transport of Pb by plants was not detected. Senescent macrophytes accumulated more lead (248 to 361 micro g Pb/g) than live plants. Crayfish exposed to contaminated sediment accumulated Pb principally through adsorption to the exoskeleton and lost Pb through molting, although internal uptake and elimination without molting was measurable. Exposure to Pb leached from sediment, surface to weight ratios, and frequency of molting seem to influence Pb uptake by crayfish. Lead concentrations in crayfish collected during the exposure period ranged from 2 to 310 micro g Pb/g. The uptake of Pb by macrophytes and crayfish exposed to contaminated sediments is consistent with the role of sediment not only as a sink for metal contamination but also as a continuous source of heavy metals to the aquatic biota after contamination from the original source has subsided. (Moore-IVI)
W84-05190

ACUTE TOXICITY OF BUTYLBENZYL PHTHALATE TO SHINER PERCH (CYMATOGASTER AGGREGATA),
Corvallis Environmental Research Lab., OR.
R. J. Ozretich, R. C. Randall, B. L. Boese, W. P. Schroeder, and J. R. Smith.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 655-660, November, 1983. 2 Fig, 2 Tab, 26 Ref. NIEHS grant ESO 1926.

Descriptors: *Toxicity, *Butylbenzyl phthalate, *Perch, Phthalate esters, Bioassay, Fish behavior, Catecholamines, Industrial chemicals.

Butylbenzyl phthalate (BBP) is a member of a class of compounds which are esters of phthalic anhydride, and are used extensively in the plastics industry. As a result of the ubiquity of BBP in environmental samples and its high production, the EPA included it with several other phthalate esters in a list of toxic pollutants, for which acute bioassays are required for at least two different fish families. Static bioassay LC50s for butylbenzyl phthalate (BBP) for a single species of marine fish were based on nominal doses range from 3 mg/L to 440 mg/L. Flow-through bioassays were used in this study of BBP with shiner perch (Cymatogaster aggregata). Using measured exposure concentrations, 96-hr LC50s averaged 0.51 mg/L. Effects on schooling behavior were found at 0.08 mg/L and coloration at 0.24 mg/L. Coupled with the behavioral changes, reduced brain levels of epinephrine found in surviving fish indicated that the mode of acute toxicity for BBP may be through its effects on the catecholamines of the central adrenergic nervous system. At concentrations as low as 0.08 mg/L, behavior which can be essential to survival in the wild can be altered. (Moore-IVI)
W84-05194

ACUTE TOXICITY OF TEN CHLORINATED ALIPHATIC HYDROCARBONS TO THE FATHEAD MINNOW (PIMEPHALES PROMELAS),
Environmental Research Lab.-Duluth, MN.
C. T. Walbridge, J. T. Fiandt, G. L. Phipps, and G. W. Holcombe.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 661-666, November, 1983. 3 Tab, 26 Ref.

Descriptors: *Toxicity, *Chlorinated ethanes, *Minnows, Chlorinated hydrocarbons, Aliphatic hydrocarbons, Solvents, Water pollution effects, Industrial chemicals, Tetrachloroethylene, Tetrachloroethane, Pentachloroethane, Trichloroethane, Hexachlorobutadiene, Trichloroethylene, Dichloropropane, Dichloroethane, Hexachloroethane, Dichloropropane.

The tested chlorinate ethanes are used for metal cleaning in industry, as solvents for waxes, oils, and resins, and as chemical feedstocks. Ninety-six hour LC50 values were determined for 10 chlorinated aliphatic hydrocarbons in freshwater flow-through toxicity tests on fathead minnows (Pimephales promelas). Laboratory-reared minnows, 30 to 35 days old were used. With the exception of hexachlorobutadiene, the effect of these compounds is narcotic; lethargy and anesthesia are observed. The directly observable effect of hexachlorobutadiene is hemorrhaging. The toxicity

goes up directly with the ratio of chlorine to total molecular weight. The 96-hr measured LC50 values in mg/L from combined duplicate tanks were: tetrachloroethylene 13.4; 1,1',2,2'-tetrachloroethane 20.4; pentachloroethane 7.34; 1,1',2-trichloroethane 81.6; hexachlorobutadiene 0.10; 1,1'2-trichloroethylene 45.0; 1,2-dichloropropane 140; 1,2-dichloroethane 116; hexachloroethane 1.51; 1,3-dichloropropane 131. The 1,1',2-trichloroethane results were unusual in that all of the deaths that were to occur during the four days of the test happened in the first five hours. (Moore-IVI)
W84-05195

ACTIVITY AND INDUCIBILITY OF ARYL HYDROCARBON HYDROXYLASE IN THE EELPOUT ZOARCES VIVIPARUS (L.),
Odense Univ. (Denmark). Inst. of Biochemistry.
R. Jensen, and J. Knudsen.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 673-678, November, 1983. 10 Fig, 33 Ref.

Descriptors: *Aryl hydrocarbon hydroxylase, *Zoarces, *Naphthalene, Polycyclic aromatic hydrocarbons, Toxicity, Metabolism, Oil pollution, Water pollution effects, Embryonic growth stage.

Naphthalene, a major component of the water soluble fraction of oil, is usable as a model substrate for the metabolic activation of other polycyclic aromatic hydrocarbons (PAH). Naphthylene and other PAHs are metabolized via aryl hydrocarbon hydroxylase (AHH). The AHH activity in eelpout liver microsomes was determined with C-14-naphthalene as substrate. Exposure to 0.5 ppm naphthalene in the water for one week or intraperitoneal injection (ip.) of naphthalene in peanut oil (100 mg/kg) did not induce AHH activity in the liver microsomes of adult female eelpouts, which was in contrast to ip. of 5,6-benzoflavone (5,6-BF) (100 mg/kg) which increased the AHH activity three fold. 7,8-Benzoflavone (7,8-BF) inhibited the AHH activity in vitro in 5,6-BF induced fish, but it increased the AHH activity in control fish. The AHH system in eelpout embryos was almost fully active before parturition, and no major change took place at parturition. (Moore-IVI)
W84-05196

ACUTE AND CHRONIC TOXICITY OF SOME CHLORINATED BENZENES, CHLORINATED ETHANES, AND TETRACHLOROETHYLENE TO DAPHNIA MAGNA,
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
J. E. Richter, S. F. Peterson, and C. F. Kleiner.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 679-684, November, 1983. 3 Tab, 18 Ref.

Descriptors: *Toxicity, *Daphnia, *Chlorinated hydrocarbons, Growth, Reproduction, Tetrachloroethylene, Hexachloroethane, Pentachloroethane, Tetrachloroethane, Trichloroethane, Dichloroethane, Trichlorobenzene, Dichlorobenzene.

Chronic effect and no effect concentrations (28 day) and acute toxicity (48 hr, LC50 and EC50) values were determined for Daphnia magna with some chlorinated benzenes, chlorinated ethanes, and tetrachloroethylene. Acute and chronic toxicity generally increased with the degree of chlorine substitution with these chemicals. The 48 hr LC50 values for hexachloroethane, pentachloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2,4-trichlorobenzene, 1,3-dichlorobenzene, and tetrachloroethylene were 2.9, 7.3, 62, 190, 270, 2.1, 7.4, and 18 mg/L, respectively. The lowest observable effect concentrations (LOEC) based on either reproductive impairment or growth for 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2,4-trichlorobenzene, 1,3-dichlorobenzene, and tetrachloroethylene were 14, 26, 20, 0.69, 1.5, and 1.1 mg/L, respectively. Length of animals at the end of chronic exposure was at least as sensitive a measure of toxic effect as reproduction with every chemical tested except 1,2-dichloroethane. The acute-chronic ratio ranged from 3 to 16 with these chemicals. (Author's abstract)
W84-05197

SLOW ACCUMULATION OF LEAD FROM CONTAMINATED FOOD SOURCES BY THE FRESHWATER GASTROPODS, PHYSA INTEGRA AND CAMPELOMA DECISUM,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
M. C. Newman, and A. W. McIntosh.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 685-692, November, 1983. 2 Fig, 3 Tab, 13 Ref. Contract DE-AC09-76-SROO-H19.

Descriptors: *Lead, *Gastropods, *Food, Aufwuchs, Heavy metals, Snails, Water pollution effects, Physa, Campeloma.

The relative significance of dietary and water sources of lead to aquatic biota remains generally unresolved. The accumulation of lead from two highly contaminated food sources was examined in order to further define the factors contributing to the observed differences in soft tissue lead concentrations in the freshwater gastropods Physa integra and Campeloma decisum. Lead was slowly accumulated from aufwuchs (0.52-0.87 micro g Pb/g dry wt of tissue/day) by the grazing snail, P. integra while no statistically significant lead accumulation from sediments was noted in the deposit/suspension feeder, C. decisum. Lead concentrations in all of the aufwuchs samples were approximately 125 micro g Pb/g dry weight. Aufwuchs-associated iron and manganese did not affect the bioavailability of lead. C. decisum appears to be able to control the amount of lead accumulating in its tissues. (Moore-IVI)
W84-05198

AVOIDANCE BEHAVIOR OF JUVENILE STRIPED BASS, MORONE SAXATILIS, SUBJECTED TO SIMULTANEOUS CHLORINE AND ELEVATED TEMPERATURE CONDITIONS,
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
L. W. Hall, Jr., S. L. Margrey, D. T. Burton, and W. C. Graves.
Archives of Environmental Contamination and Toxicology, Vol. 12, No. 6, p 715-720, November, 1983. 4 Fig, 4 Tab, 22 Ref. Maryland Power Plant Siting Program contract P83-81-04.

Descriptors: *Bass, *Avoidance behavior, *Chlorine, *Water temperature, Juvenile growth stage, Fish behavior, Acclimation, Residual chlorine, Water pollution effects.

The avoidance responses of juvenile striped bass (Morone saxatilis) were evaluated by exposing test organisms to simultaneous elevated temperature (0, 2, 4, and 6 degrees C) and total residual chlorine (TRC) (0.00, 0.05, 0.10 and 0.15 mg/L) conditions at four acclimation temperatures ranging from 15-30 degrees C. An unbalanced 3-factor factorial design was used to develop response surface avoidance models at all acclimation temperatures. The percent avoidance models at 15 degrees C showed that the interaction term (TRC x delta T) was the most important term influencing avoidance; TRC was the most important factor at 20 degrees C; the models at 25 and 30 degrees C showed that delta T was the most important factor. The results of tests conducted at 15 degrees C suggest that preference for a higher temperature overrides a chlorine avoidance response to 0.15 mg/L TRC. Avoidance responses of striped bass tested at acclimation temperatures of 20, 25, and 30 degrees C showed that preference for a higher temperature (6 degrees C delta T) did not override a chlorine avoidance response. A significant difference ($p < 0.01$) existed between avoidance models at all acclimation temperatures; greatest avoidance generally occurred for all combinations of test conditions at 30 degrees C. (Author's abstract)
W84-05201

PALEOLIMNOLOGICAL RECONSTRUCTION OF THE EFFECTS OF ATMOSPHERIC DEPOSITION OF ACIDS AND HEAVY METALS ON THE CHEMISTRY AND BIOLOGY OF LAKES IN NEW ENGLAND AND NORWAY,
Maine Univ. at Orono. Dept. of Botany and Plant Pathology.
R. B. Davis, S. A. Norton, C. T. Hess, and D. F. Brakke.
Hydrobiologia, Vol. 103, 113-123, July, 1983. 8 Fig, 29 Ref. NSF grant DEB7810641, FWS grant 1416000979040, USDA grant ME08465 and OWRT grant A048ME.

Descriptors: *Lake acidification, *Norway, *New England, *Heavy metals, *Paleolimnology, Acid rain, Atmospheric deposition, Cladocera, Cesium radioisotopes, Lead radioisotopes, Pollen, Diatoms, Soil erosion, Iron, Soil acidification, Land use, Water pollution sources.

The degree and chronology of acidification and associated pollution of lakes in southern Norway and northern New England by heavy metals is poorly known, due to the scarcity of long-term series of direct measurements. Sediment cores from nine lakes in southern Norway (N) and six in northern New England (NE) were dated by Cs-137, Pb-210 and in NE also by pollen, and were analyzed geochemically and for diatoms. Cores from two N and three NE lakes were analyzed for cladocerans; Cs-137 dating is unreliable in these lakes, probably due to mobility of Cs in the sediment. In Holmvatn sediment, an up-core increase in Fe, starting ca. 1900, correlates with geochemical indications of decreasing mechanical erosion of soils. Diatoms indicate a lake acidification starting in the 1920's. Soil Fe was mobilized and runoff acidified by acidic precipitation and/or by soil acidification resulting from vegetational succession following reduced grazing. Even minor land use changes or disturbances in lake watersheds introduce ambiguity to the sedimentary evidence relating to atmospheric influences. Diatom counts from surface sediments in 36 N and 31 NE lakes were regressed against contemporary water pH to obtain coefficients for computing past pH from subsurface counts. Computed decreases of 0.3-0.8 pH units starts between 1890 and 1930 in N lakes already acidic (pH 5.0-5.5) before the decrease. These and lesser decreases in other lakes start decades to over a century after the first sedimentary indications of atmospheric heavy metal pollution. The acidification of precipitation probably accompanied the metal pollution. Delays in lake acidification may be due to buffering by the lakes and watersheds. The magnitude of acidification and heavy metals loading of the lakes parallels air pollution gradients. A shift in cladoceran remains is contemporary with acidification, preceding elimination of fishes. (Moore-IVI)
W84-05215

CULTURAL DISTURBANCES AND TROPHIC HISTORY OF A SMALL MEROMICTIC LAKE FROM CENTRAL CANADA,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
J. P. Smol, S. R. Brown, and R. N. McNeely.
Hydrobiologia, Vol. 103, p 125-130, July, 1983. 4 Fig, 34 Ref. Natural Sciences and Engineering Research Council of Canada grant A-808.

Descriptors: *Meromictic lakes, *Eutrophication, *Little Round Lake, *Ontario, *Salt, Highways, Environmental effects, Pollen, Limnology, Diatoms, Logging, Chrysophyta, Oligotrophy.

Little Round Lake occupies a small, deep, cup-shaped basin in southeastern Ontario. The lake is presently oligo-mesotrophic and is chemically stratified with a distinct chemocline near the 11 m level. The watershed has been subjected to moderate cultural disturbances over the last century; first by loggers and the building of a railroad adjacent to the lake, and later by the construction of two highways. Pollen analyses were used to identify past changes in terrestrial vegetation, while limnological conditions were interpreted on the basis of diatom and chrysophyte microfossils. Contemporaneous with the arrival of European settlers (ca. A.D. 1850), the predisturbance assemblage of oligotrophic Cyclotella diatoms was replaced by Synedra spp., which then succeeded to a eutrophic flora dominated by Stephanodiscus hantzschii. Synuracean algae were almost completely ex-

cluded. Both the diatom and chrysophyte microfossils recorded a marked return to oligotrophy over the last 30 years. Stephanodiscus hantzschii was reduced to trace levels and the diatom assemblage was dominated by oligotrophic taxa. Synuracean scales were common. This shift may be related to the cultural enhancement of meromixis by the seepage of road salt from the two adjacent highways and a salt storage shed in the drainage basin. Although an increase in meromictic stability appears to have greatly reduced algal productivity, the species composition in the surface sediments suggests that the lake is still slightly more eutrophic than it was prior to man's arrival. (Moore-IVI)
W84-05216

CHANGES OF THE BENTHIC FAUNA OF THE PROFUNDAL ZONE OF TRAUNSEE (AUSTRIA) DUE TO SALT MINING ACTIVITIES,
Vienna Univ. (Austria). Limnologische Lehrkanzel.
H. Loffler.
Hydrobiologia, Vol. 103, p 135-139, July, 1983. 3 Fig, 1 Tab, 13 Ref.

Descriptors: *Water pollution effects, *Benthic fauna, *Traunsee, *Austria, *Salt mining, Mine wastes, Mine drainage, Alkalinity, Paleolimnology, Artificial meromixis, Ostracods.

Traunsee is the deepest (189 m) lake in Austria and has been holomictic until the beginning of industrial discharges from the alkali works in Ebensee. The input of soluble compounds such as CaCl2 and NaCl have produced meromictic conditions. The relatively high oxygen content of the monimolimnion is due to water movements promoted by the large inflow and wind-action. The industrial discharges have caused both meromictic conditions and the deposition of highly alkaline sediment in the southern portion of the profundal zone. The effect of the discharges on the benthic fauna was evaluated by comparing the subfossil benthic fauna of four cores taken inside and outside the affected area. The ostracod fauna resembles that of other large lakes in the Salzkammergut, but also includes groundwater species such as Kovalevskiella and Cypridopsis subterranea. Leucocythere mirabilis has been found for the first time in an Australian lake. Ostracods and other benthic organisms such as Testacea were not apparently influenced by the meromictic condition. They are, however, missing in all areas covered by the alkaline sludge. (Author's abstract)
W84-05218

CLADOCERAN REMAINS AS EVIDENCE OF CHANGE IN TROPHIC STATE IN THREE SWISS LAKES,
Indiana Univ. at Bloomington. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W84-05219

EUTROPHICATION PROCESSES IN SPANISH RESERVOIRS AS REVEALED BY BIOLOGICAL RECORDS IN PROFUNDAL SEDIMENTS,
Barcelona Univ. (Spain). Facultat de Biologia.
For primary bibliographic entry see Field 2H.
W84-05221

EUTROPHICATION AND THE DISAPPEARANCE OF LAKES IN THE BRODNICA LAKE DISTRICT, NORTHERN POLAND AS A RESULT OF HUMAN INTERFERENCE,
Nicolas Copernicus Univ. of Torun (Poland). Inst of Geography.
For primary bibliographic entry see Field 2H.
W84-05223

ZN, P AND ATP IN THE SEDIMENTS OF TWO LAKES IN SOUTH FINLAND,
Tampere Univ. of Technology (Finland).
L. Koivo, and R. Oravainen.
Hydrobiologia, Vol. 103, p 177-179, July, 1983. 1 Fig, 3 Tab, 5 Ref.

Descriptors: *Lake sediments, *Tampere, *Finland, Zinc, *Phosphorus, *Adenosine triphosphate, Industrial wastes, Municipal wastes, Sedimentation, Textile plants, Pulp and paper industry, Pulp wastes, Eutrophication.

The impact of industrial and municipal waste discharge on lakes near the city of Tamere, Finland was investigated. The record of P, Zn and ATP in the recent sediments of Vanajavesi I, a polluted lake, and Mallasvesi, a largely unpolluted lake, are compared. The study lakes are situated in the Kokemaenjoki watercourse in South Finland, with an area of about 27,040 sq km. Sources of pollution in the area are pulp and paper mills, textile factories, municipal sewage plants and fish-farms. Mallasvesi is a clear water lake with a low nutrient and electrolyte status although oxygen deficiency occurs in depressions in the lake bed during stratification. There is a slight increase in P values in the upper 30 cm, but Zn values are consistently low throughout. Vanajavesis I is heavily polluted due to discharge of industrial and municipal effluents. The zinc load (1000 kg/day) from a textile factory has been cut recently to 100 kg/d. Other problems have begun to improve due to the installation of a wastewater treatment plant. (Baker-IVI)
W84-05224

CLOSTRIDIUM PERFRINGENS (HOLLAND) AS AN INDICATOR OF HUMAN EFFLUENT IN THE SEDIMENT OF LAKE TUOMIOJARVI, CENTRAL FINLAND,
Jyvaeskylae Univ. (Finland). Hydrobiological Research Center.
K. Granberg.
Hydrobiologia, Vol. 103, p 181-184, July, 1983. 2 Fig, 1 Tab, 11 Ref.

Descriptors: *Eutrophication, *Lake Tuomiojarvi, *Finland, *Clostridium, Lake sediments, Domestic wastes, Wastewater, Paleolimnology, Bacteria.

The horizontal and vertical distribution of the gram-positive, non-motile, spore-forming and rod-shaped bacterium Clostridium perfringes was studied to estimate the quantity of C. perfringens at different depths of the sediment in Lake Tuomiojarvi and, thereby, evaluate the effect of human effluent which the lake received between 1940 and 1956. The amounts of Clostridium increased at the same level (40 mm) where redox potential decreased in the sediment due to the beginning of effluent disposal. The maximum Cu:Zn ratio seems to have been in the 1950's. A slight increase in loss of ignition values is noted and may be related to enrichment processes in the lake. The amount of chlorophyll a in the sediment varied between 42 and 74 micro g/g dry weight. An increase is seen in the top 20 mm. The comparison of chlorophyll a to the numbers of diatom values does not show a clear correlation. At 35 mm the number of diatoms decreases although the amount of chlorophyll a increases. The pre-pollution level of Clostridium in Lake Tuomiojarvi is less than 300 colonies/g dry weight, judging from the values found in the sediment deeper than 30 mm. (Baker-IVI)
W84-05225

SYSMAJARVI - A LAKE POLLUTED BY MINING WASTE-WATER,
North Karelian Water District Office, Joensuu (Finland).
M. Ahtiainen, O. Sandman, and R. Tynni.
Hydrobiologia, Vol. 103, p 303-308, July, 1983. 5 Fig, 2 Tab, 9 Ref.

Descriptors: *Lake sediments, *Mine wastes, *Lake Sysmajarvi, Industrial wastes, Heavy metals, Diatoms, Paleolimnology, Acid mine drainage, Lime, History, Nutrients, Water pollution effects.

Lake Sysmajarvi is located inside the municipal boundary of Outokumpu, Finland. The evolution of Lake Sysmajarvi was investigated with special respect to the effects of acidification and subsequent liming recorded by the diatom flora and heavy metal content of the sediment and by historical records. According to the pollen diagram and pollen zonation, the base of the 480 cm sediment core from the deep part of the lake belongs to the Preboreal Betula-phase, Zone IV. The whole core spans more than 9000 years. The lower part of the sediment was deposited in the Yoldia phase: the typical diatom at 440 cm is Melosira islandica spp. helvetica and there is also a small quantity of Diploneis interrupta. In the short core the influence of man can be detected from about 40 cm to the sediment surface, represented by increases in the proportion of organic matter, alkaliphilous and alkalibionitic diatoms and heavy metals. This change can be attributed to the effect of waste from the mining industry. The radical pH changes seem to have had a smaller influence on the amounts of organic matter and metals in the sediment. Some of the water polluted by the mining waste and most of the municipal sewage enters via the river Lahenjoki. The effects of large amounts of nutrients can be noticed most clearly where the river enters the lake, but effects can also be noted over the whole eastern, shallow part of the lake. (Baker-IVI)
W84-05227

ATTEMPT TO TRACE EUTROPHICATION IN A SHALLOW LAKE (BALATON, HUNGARY) USING CHIRONOMIDS,
Lajos Kossuth Univ., Debrecen (Hungary). Dept. of Ecology.
G. Devai, and J. Moldovan.
Hydrobiologia, Vol. 103, p 169-175, July, 1983. 5 Fig, 15 Ref.

Descriptors: *Eutrophication, *Tracers, *Lake Balaton, *Hungary, *Chironomids, Water quality, Paleolimnology, Subfossil remains, Eutrophic lakes.

Lake Balaton, the largest shallow lake in Central Europe, is about 20000 years old. An enormous increase in tourism and the disproportionate building development of the last few decades has resulted in the acceleration of eutrophication in the lake. The larvae of non-biting midges (Diptera: Chironomidae) in the sediment of the open-water zone was investigated to reveal the causes of water-quality deterioration. The contemporary faunal composition strongly correlates with the trophic gradient along the longitudinal axis of the lake. It is supposed that the eutrophication process should be identifiable from the analysis of subfossil chironomid head capsules from the upper (15 cm thick) layer of the sediment. Quantitative results could only be obtained when fragments as well as relatively intact head capsules are considered. The data verify that the originally oligo-mesotrophic community has been gradually replaced by eutrophic species in a west to east direction. Large-bodied larvae belonging to the Chironomus plumosus group mix the sediment down to 15 cm as they build their tubes and consequently alter the original proportions of head capsules at the different levels. The sequence of communities through the sediment-layers is not quite reliable. (Murphy-IVI)
W84-05229

NOTES ON THE ROTIFERS OF COAL MINE WATER IN EASTERN POLAND,
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
S. Radwan, and A. Paleolog.
Hydrobiologia, Vol. 104, p 307-309, August, 1983. 3 Fig, 8 Ref.

Descriptors: *Coal mine wastes, *Reservoirs, *Rotifers, *Poland, Eutrophication, Sulfides, Chlorides, Temperature effects, Water pollution effects.

The species composition and quantitative structure of the rotifer fauna was investigated in a reservoir containing coal mine water. Only nine mainly planktonic species of rotifers were found. Two of these dominated: Brachionus angularis and B. rubens. They are typical indicators of eutrophic waters. Chlorides and sulfates may have an influence on the occurrence and quantitative structure of rotifer assemblages in the investigated reservoir. There was a clear positive correlation between temperature, dissolved oxygen concentration and abundance of predominating rotifers, just as in natural lakes. However, with a decrease in temperature connected with an increase of oxygen con-

centration, the abundance of some rotifer species decreased. (Baker-IVI)
W84-05230

PRODUCTION OF PLANKTONIC ROTATORIA IN ORMAJARVI, AN EUTROPHICATED LAKE IN SOUTHERN FINLAND,
Helsinki Univ. (Finland). Dept. of Environmental Science.
V. Cajander.
Hydrobiologia, Vol. 104, p 329-333, May, 1983. 1 Fig, 2 Tab, 25 Ref.

Descriptors: *Rotifers, *Eutrophic lakes, *Lake Ormajarvi, *Finland, Aquatic productivity, Secondary productivity, Species composition.

Rotifers can make a substantial contribution to secondary production in fresh waters in spite of their small relative contribution to total zooplankton biomass. It has been noticed that the eutrophication process can strongly affect numbers, standing crops, population dynamics, production and community structure of zooplankton. Such trophic changes in lake ecosystems are often favorable for rotifers. The production of planktonic rotifers was studied in eutrophic Lake Ormajarvi. Of the total annual production of rotifers (2.9 g org. C/sq m or 231 mg dry weight/cu m) 49% was achieved during one month (July) and 88% during 3 months of summer. The most important producers were Keratella cochlearis (1.2 g C/sq m), Asplanchna priodonta (0.8 g C/sq m) and Conochilus unicornis (0.6 g C/sq m). The P/B ratio for the total rotifer community during the growing season (7 months) was 25.0; monthly P/B values varied between 0.3 and 5.2. The daily P/B values were highest among species of Collotheca. The relationships of rotifers to some biotic and abiotic factors (invertebrate predators - Mesocyclops, Cladocera, planktonic Protozoa and temperature) are briefly discussed. (Murphy-IVI)
W84-05231

IMPORTANCE OF BIOTESTS TO DETERMINE THE TOXIC EFFECTS OF SEWAGE (DIE BEDEUTUNG VON BIOTESTS FUR DIE TOXIZITATSBESTIMMUNG VON ABWASSER),
BASF A.G., Ludwigshafen am Rhein (Germany, F.R.).
U. Pagga.
Wasserwirtschaft, Vol. 73, No. 3, p 65-70, March, 1983. 9 Fig, 7 Ref.

Descriptors: *Biological wastewater treatment, *Toxicity, *Bioassay, Measuring instruments, Sublethal effects, Water pollution effects, Chemical composition, Chemical analysis.

Purification plants are nothing more than breeding grounds for microorganisms. Some significant problems will arise if toxic substances enter these biological wastewater treatment processes. To reduce the hazard biotests are conducted to determine the extent of the toxic substance intrusion. Toxic effects of chemical substances and waste water on activated sludge and water organisms are discussed. Principal methods to measure these effects are a short time respiration test and a respirometric test with activated sludge, a continuous respiration test called a BASF-Toximeter to monitor a waste water, an enzymatic test (TTC-Test), an acute fish test with golden ides and a long time test with waterfleas (Daphnia), to detect sublethal effects. Finally the evaluation of test results is discussed. (Murphy-IVI)
W84-05233

WATER SODIUM AND BLOOD PRESSURE IN RURAL SCHOOL CHILDREN,
Medical Research Council, Harrow (England). Epidemiology and Preventive Medicine.
B. K. Armstrong, B. M. Margetts, M. G. McCall, C. W. Binns, and N. A. Campbell.
Archives of Environmental Health, Vol. 37, No. 4, p 236-245, July-August, 1982. 2 Fig, 5 Tab, 22 Ref.

Descriptors: *Salinity, *Blood pressure, *Australia, Hypertension, Chemical properties, Biological magnification, Bioaccumulation.

Blood pressures were measured in 326 boys and 309 girls, 12 to 14 yr of age, who attended schools in six rural towns with water sodium levels ranging from 1.46 to 9.69 mmol/L. Although there were significant differences between mean blood pressure levels in children living in the six towns, they did not appear to result from differences in water sodium levels. Children who lived on farms and who drank low-sodium rain water did not have lower blood pressures than children who lived in the towns. The estimated intake of sodium from drinking water in the towns varied between 1.5 and 11.6 mmol/day and represented between 1.2% and 10.4% of the estimated daily sodium intake. No effect of water sodium level on urinary sodium excretion was found. Blood pressure levels showed significant positive relationships with pulse rate, body height and weight, Quetelet's index, mid-upperarm circumference, and triceps skinfold thickness. Diastolic blood pressures in girls were inversely related to a measure of physical activity. Control of these variables, where relevant, by covariance analysis did not uncover any relationship between water sodium level and blood pressure. (Author's abstract)
W84-05282

EPIDEMIOLOGICAL ASSESSMENT OF WATER QUALITY AND 'SWIMMER'S EAR',
Yale Univ., New Haven, CT. Dept. of Epidemiology and Public Health.
R. Calderon, and E. W. Mood.
Archives of Environmental Health, Vol. 37, No. 5, p 300-305, September-October, 1982. 1 Fig, 5 Tab, 28 Ref.

Descriptors: *Water quality, *Bacteria, *Swimmer's ear, Otitis externa, Epidemiology, Public health, Swimming.

In an effort to determine if bacterial water quality was related to the incidence of otitis externa (swimmer's ear), a retrospective study was conducted from July 1980 to September 1980. Data from 29 cases and 29 controls matched for age and sex were collected. The disease appears to be primarily associated with people less than 18 yr of age. Hot and humid ambient air appears to be associated with it. This association may be indirect rather than direct. Hot and humid air may determine the frequency and duration a person swims during periods of extreme weather. Swimming appears to be associated, but more important is the association with the quantity of time spent in the water swimming. Otitis externa does not appear to be associated with bacterial indicators of recreational water quality such as fecal coliforms, enterococci, or P. aeruginosa organisms. While P. aeruginosa may be the most commonly isolated organism from cases of otitis externa, the role of other bacterial etiological agents should not be excluded. (Baker-IVI)
W84-05283

NORWALK GASTROENTERITIS ASSOCIATED WITH A WATER SYSTEM IN A RURAL GEORGIA COMMUNITY,
Georgia Dept. of Human Resources, Atlanta. Office of Epidemiology.
R. A. Goodman, J. W. Buehler, H. B. Greenberg, T. W. McKinley, and J. D. Smith.
Archives of Environmental Health, Vol. 37, No. 6, p 358-360, November-December, 1982. 1 Fig, 9 Ref.

Descriptors: *Norwalk virus, *Water pollution effects, *Gastroenteritis, *Georgia, Coliforms, Viruses, Rainfall, Surface runoff, Public health, Water pollution sources, Springs.

An outbreak of acute gastroenteritis occurred during January 4-9, 1982, in a rural community in north Georgia. A systematic telephone survey revealed that 63% of the persons living in homes served by the community water system had symptoms of acute gastroenteritis in contrast to 9% of the persons in homes served by private wells or other sources. A fourfold rise in antibody titer to the Norwalk virus occurred in 20 of 22 serum pairs obtained from ill persons. Fecal coliforms were detected in a spring which served as one water source for the community system. Surface runoff from a heavy rainfall, which preceded the outbreak, may have contaminated the system. Inspection of the four sources in this system revealed two possible sites of contamination, including the spring in which fecal coliforms were detected. That spring was subject to contamination because its cover was in poor repair, the spring was open to ground water runoff from nearby homes with septic tanks and penned animals and to the excreta of several hogs that had direct access to the spring. In addition, the 2 inch polyvinyl chloride pipe, which carried water from this spring, was on the surface of the ground. Contaminated surface water may have entered the system through pipe joints loosened possibly by grazing animals or from freezing and thawing. The well casing of the single well was recessed below the ground level and had been exposed to flooding by surface water during unusually heavy rainfall. (Baker-IVI)
W84-05284

INFLUENCE OF COMBINED SEWAGE OUTFALL ON THE CHEMICAL AND BIOLOGICAL QUALITY OF SALT CREEK, PORTER COUNTY, INDIANA,
Indiana Univ. Northwest, Gary. Dept. of Biology.
R. L. Whitman.
Proceedings of the Indiana Academy of Sciences, Vol. 92, p 275-282, 1982. 4 Fig, 14 Ref.

Descriptors: *Wastewater outfall, *Water quality, Indiana, Porter County, Salt Creek, Salmon, Ammonia, Acidity, Nitrates, Phosphates, Sulfates, Chlorides, Sediments, Oxygen demand, Dissolved oxygen, Valparaiso.

Analyses of dissolved oxygen, specific conductance, pH, ammonia, nitrate, total phosphate, sulfate, chloride sediment oxygen demand and organic content and biological species diversity during July, August, September of 1980 and April of 1981 of Salt Creek waters indicated that the Valparaiso Combined Sewage Outfall (CSO) was the major contributor to the degradation of the stream's water and sediment quality. Little evidence of organic and sediment loading from agricultural practices was noted. Sand mining operations at the headwaters of Sager Creek above Sager Lake may significantly impact upstream ecosystems and potential salmon spawning areas. An undocumented sewage outfall between Horse Prairie Road and U.S. Highway 30 is strongly suspected although water quality data obtained here was inconsistent. In spite of heavy pollution imposed on the stream by these point sources, the stream at base flow conditions appeared capable of limited recovery about 9.0 to 12.6 km downstream of the Valparaiso CSO. The heaviest pollution, unfortunately, took place at stream locations with the greatest salmon spawning potential. Diurnal analyses indicated that episodes of significant rainfall coincided with anaerobic conditions in areas downstream of the Valparaiso CSO and with depressed oxygen levels as far north as the State Highway 6 station. Under these conditions of water quality, possible sediment loading from sand mining operations, and limited suitable spawning substrates, it is unlikely that Salt Creek's potential as a salmon fishery will improve. (Baker-IVI)
W84-05310

FISH DISTRIBUTION IN THE VICINITY OF BRUNNER ISLAND STEAM ELECTRIC STATION,
York Coll. of Pennsylvania. Dept. of Biological Sciences.
R. F. Denoncourt.
Proceedings of the Pennsylvania Academy of Science, Vol. 57, No. 2, p 165-172, 1983. 2 Fig, 3 Tab, 36 Ref.

Descriptors: *Fish, *Water pollution effects, *Powerplants, Cooling water, Seasonal variation, Brunner Island Steam Electric Plant, York County, Pennsylvania.

Three seasonal fish surveys were conducted in 1977-78 to determine relative abundance of fishes in the vicinity of Brunner Island Steam Electric

Station (BISES), York County, Pennsylvania. Emphasis was placed upon comparisons between control and stations affected by the cooling water discharge of this fossil fuel generating facility. A total of 43 fish species was found in the vicinity. Species number increased in winter at the affected stations with a decrease in diversity, percent similarity and Spearman Rank correlations in spring through summer. Winter diversity and abundance at affected stations was similar to spring and summer diversity at control stations. An obvious attraction/concentration occurred in winter within the warmer discharge waters followed by spring dispersal stimulated by preference, avoidance, natural migration and prey attraction. The August 1980 survey at five paired stations (experimental and control) showed reduced diversity in warmer waters close to the effluent source. Water temperatures, fish biomass, length frequencies and species diversity were similar by station sets 4 and 5 where percent similarities increaed and Spearman Rank correlations were significant. The data suggested fish community recovery or minimal effect between 6.6 and 11 km below the cooling water discharge. (Baker-IVI)
W84-05314

PRELIMINARY SURVEY OF POCONO MOUNTAIN LAKES TO DETERMINE SENSITIVITY TO ACID DEPOSITION,
Lehigh Univ., Bethlehem, PA. Dept. of Biology.
P. T. Bradt, and M. B. Berg.
Proceedings of the Pennsylvania Academy of Science, Vol. 57, No. 2, p 190-194, 1983. 5 Fig, 4 Tab, 14 Ref.

Descriptors: *Mountain lakes, *Acidity, Pocono Mountains, Pennsylvania, Lakes, Alkalinity, Drainage basins.

Ten lakes in the Pocono Mountain area of eastern Pennsylvania were sampled chemically in 1981 to determine their sensitivity to effects from acid deposition. The pH of precipitation in eastern Pennsylvania averages from 4.1 to 4.3. When acid precipitation falls on a lake with low alkalinity the pH of the lake may be decreased to a level at which fish, macroinvertebrates or algal populations may be reduced and/or altered. The ten lakes were located in Monroe, Pike, and Wayne counties, which are all underlain with insoluble bedrock. Each lake was small, in an undisturbed drainage basin, shallow, high altitude, having headwaters, in a low drainage basin area to lake surface area ratio, and natural or, if man made, at least 50 yr old. The pH of the lakes ranged from 4.6 to 7.0, total alkalinity from 0.0 to 210 microeq/l and conductivity from 11 to 41 microm hos/cm. Three of the lakes (Deep, Lacawac and Long) were chosen for study intensively, biologically and chemically for three years. All three lakes have available historical data, biological, chemical or both. These represent one acidified lake and two moderately sensitive lakes although Lacawac has a lower total alkalinity (45 microeq/l) than Long Pond (115 microeq/l). (Baker-IVI)
W84-05315

DIVERSITY, BIOTIC AND SIMILARITY INDICES, A REVIEW WITH SPECIAL RELEVANCE TO AQUATIC ECOSYSTEMS,
Commonwealth Scientific and Industrial Research Organization, Ryde (Australia). Div. of Fossil Fuels.
H. G. Washington.
Water Research, Vol. 18, No. 6, p 653-694, 1984. 5 Fig, 11 Tab. 98 Ref.

Descriptors: *Species diversity, *Bioindicators, *Water pollution effects, Ecosystems, Organic compounds, Stability analysis, Similarity indices.

Diversity Indices, Biotic Indices and Similarity Indices are reviewed with special consideration of their ecological application, both theoretical and practical. Eighteen diversity indices in eight groups, nineteen biotic indices in ten groups and five similarity indices are examined for their applicability to biological systems, particularly aquatic ecosystems. Biotic indices are highly specialized for a particular type of water pollution, usually organic pollution. In their present form, however, such indices are necessarily limited to the geographical area in which the tolerance lists were compiled. The five similarity indices examined have been used in aquatic systems. It is not clear which of these indices is best to use. While some appear better than others, there is a need for further research and field testing of similarity indices for water pollution. The relationship and definitions of diversity and stability are examined. Diversity does not automatically lead to either stability or instability but may be found with both. Disturbance to an ecosystem may often increase diversity provided it is of intermediate frequency, yet an ecosystem may also become more diverse without becoming less stable. It is urged that the use of inappropriate indices will be abandoned and concentration will be placed on indices which look promising to studying the effects caused by water pollution. (Baker-IVI)
W84-05316

EVALUATION OF THE RELATIVE IMPORTANCE OF FOOD AND WATER AS SOURCES OF P,P-DDT TO THE GOLDFISH, CARASSIUS AURATUS (L.),
Plymouth Polytechnic (England). Dept. of Environmental Sciences.
M. M. Rhead, and J. M. Perkins.
Water Research, Vol. 18, No. 6, p 719-725, 1984. 3 Fig, 1 Tab, 41 Ref.

Descriptors: *Pesticides, *Fish, Water pollution effects, Bioaccumulation, Organic compounds, DDT, Adsorption.

Goldfish were simultaneously exposed to p,p'-DDT from two sources, food and water, distinguishable unequivocally through the use of two radioactive labels. The concentration of DDT in food was maintained at about 1 microg/g while water concentration was 2, 20, or 177 ng/cu dm. The contribution of p,p'-DDT from food to the total body residue varied over the duration of the exposure from 0 to 81% at water concentrations of 2 ng/cu dm and from 3.8 to 4.8% for water concentrations about 171 ng/cu dm. The fish exposed to DDT-contaminated food and water simultaneously apparently accumulated p,p-DDT from the two sources additively. The importance of each source may be determined by its relative concentration over the period of exposure. The p,p'-DDT taken up by goldfish was converted, first slowly and then more rapidly to p,p'-DDE, reaching a maximum of over 80% from both water and food sources after about 40 days. Dietary p,p'-DDT was converted to p,p'-DDD to a greater extent than water-borne p,p'-DDT is converted to p,p'-DDD. (Baker-IVI)
W84-05318

SIMPLE, INEXPENSIVE IN SITU METHOD FOR ASSESSING ACUTE TOXICITY OF EFFLUENTS TO FISH,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
E. W. Wilde, and A. B. Parrott.
Water Research, Vol. 18, No. 6, p 783-785, 1984. 4 Fig, 1 Ref. U.S. Energy Dept. Contract No. DE-AC09-76SR00001.

Descriptors: *Fish, *Toxicity, Water pollution effects, Monitoring, Costs, Water analysis.

Test chambers for conducting in situ fish bioassays were constructed from 8 l. polyethylene bottles. Yearling fathead minnows and young-of-the-year bluegill demonstrated greater than 50% survival in the chambers after 65 days of exposure in a reservoir, river and creek. Fathead minnow survival was substantially greater than that of bluegills. The chambers provide a simple, inexpensive, sensitive technique to screen effluents for toxicity. The in situ method is more sensitive than laboratory methods in two respects: pulse discharges of toxic substances can easily be missed when effluent is collected in grab samples and transported to a laboratory for bioassay; and toxicants which dissipate rapidly, such as total residual chlorine, can be overlooked when there is a delay between collection and testing. (Baker-IVI)
W84-05324

STRATIGRAPHIC EVIDENCE OF EUTROPHICATION IN AN ESTUARY,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 2L.
W84-05327

5D. Waste Treatment Processes

KDT INFORMATION CONFERENCE ON ECONOMIC EVALUATION OF REDUCTION OF THE WASTEWATER LOAD ON WATER RESOURCES (INFORMATIONSTAGUNG DER KDT ZUR OKONOMISCHEN BEWERTUNG DER ABWASSERLASTSENKUNG IN DEN GEWASSERN),
W. Schneider.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 149-152, May, 1983.

Descriptors: *Water management, *Wastewater treatment, *East Germany, *Economic aspects, Water use, Recycling, Waste recovery, Conferences.

The Economics of Water Management Committee of the KDT sponsored a conference on the economic benefits of wastewater treatment procedures as an integral constituent of rational water use. The goal of the conference was to aid in the implementation of the German Democratic Republic directive on rational water use within the 1981-85 five-year plan by demonstrating a method of determining the benefits of reducing the wastewater load and by developing ways of improving the effectiveness of water management techniques. The role of economics in planning and operating water management facilities is growing. Lectures were given at the conference on principles, methods, and examples of evaluating measures for reducing the wastewater load on water resources; wastewater purification in conjunction with river-system analysis; reviewing water-management procedures for implementing rational water use from the technological standpoint; evaluating wastewater load reduction and fulfilling societal needs with regard to wastewater quality; results of evaluation of wastewater load reduction in the Helme area; evaluation of operational procedures for rational water use from an industrial plants point of view, and experiences and results of an evaluation of the planned enlargement of the Cottbus municipal wastewater treatment plant. Recycling of valuable chemicals in wastewater is one important economic benefit brought out by the conference. (Gish-IVI)
W84-04794

EVALUATION OF OPERATIONAL PROCEDURES FOR THE IMPLEMENTATION OF RATIONAL WATER USE FROM THE POINT OF VIEW OF AN INDUSTRIAL PLANT (BEWERTUNG BETRIEBLICHER MASSNAHMAN FUR DIE DURCHSETZUNG DER RATIONELLEN WASSERVERWENDUNG AUS DER SICHT EINES INDUSTRIEBETRIEBES),
VEB Papier und Kartonwerke, Schwedt an der Oder (German D.R.).
For primary bibliographic entry see Field 3E.
W84-04796

PUBLIC HEALTH ASPECTS OF WATER REUSE,
LunDean Environmental Co., Cincinnati, OH.
R. B. Dean, and E. Lund.
Public Health Reviews, Vol. 11, No. 3, p 239-279, July-September, 1983. 162 Ref.

Descriptors: *Water reuse, *Public health, *Reviews, Organic compounds, Wastewater treatment, Water supply development, Water management, Epidemiology, Toxicology, Nitrogen, Salts.

Reuse of wastewater is not confined to a few special cases in which a community purifies and reuses its own sewage. The pollutants in wastewater are discussed in terms of their ability to cause disease and the efficacy of treatment processes to remove them. Evidence for adverse health

effects directly attributable to wastewater in water supplies is reviewed, and the conclusion is reached that existing techniques for purifying water appear to be able to control the demonstrable hazards. The inherent difficulties in setting standards based on epidemiological or toxicological data are discussed. The public health aspects considered include water borne infections. The evaluation of hazards and risks takes into account epidemiological evidence of both direct and indirect reuse as well as toxicological evidence. Health risks from chemical contaminants are discussed with specific mention being made of salts, nitrogen compounds, other inorganic substances, organic pollutants, and products of disinfection. Pathogens that may be present in fecally polluted water include bacteria, viruses, protozoa and helminths. Treatment methods discussed include both conventional and advanced treatments, soil treatment, the capability of water treatment to remove chemical pollutants, and the removal of pathogens. Microbial, physical, and chemical indicators for water quality control are considered. (Baker-IVI)
W84-04805

IDENTIFYING ENVIRONMENTALLY ACCEPTABLE LEAST-COST POLLUTION CONTROL SYSTEMS,
Argonne National Lab., IL. Energy and Environmental Systems Div.
For primary bibliographic entry see Field 6B.
W84-04819

ROLE OF MICROORGANISMS IN THE DECOMPOSITION OF THE SUBSTANCES CONTAINED IN WASTE WATERS (DIE ROLLE DER MIKROORGANISMEN BEIM ABBAU VON ABWASSERINHALTSSTOFFEN),
Bundesanstalt fuer Wasserguete, Vienna (Austria).
W. Kohl.
Schweizerische Zeitschrift fur Hydrologie, Vol. 44, No. 2, p 204-215, 1982. 2 Fig, 5 Tab, 13 Ref.

Descriptors: *Microorganisms, *Wastewater, *Decomposition, Bacteria, Municipal wastewater, Oxygen balance, Wastewater renovation, Wastewater treatment, Biological wastewater treatment.

Ten short papers are summarized to develop an understanding of the role of microorganisms in the decomposition of wastewater. The following are the main points developed. After introduction of wastewaters from a sugar refinery, the total number of germs and the number of heterotrophic, enterobacteria, enterococci and pseudomonad colonies increase. Colibacilli, salmonellae and enterococci will multiply in waste waters that are warm and rich in nutrients, therefore wastewaters containing fecal matter and the wastewaters of the sugar refinery should not be discharged together. Waste waters with a low pH-value are bactericidal, so that they do not contain any saprophytes in spite of a KMnO4 consumption of 2700 mg/l. Below the municipal wastewater discharges, wastewater plumes are formed that can be up to several kilometers long. The heavily polluted tributaries have similar effects on the main river to those caused by wastewater discharges. In order to be able to better study the value of the data obtained from the analyses of myxobacteria, some waters were investigated for these bacteria; an average of 10-150 myxobacteria per mililiter was found. The possibility has been mentioned of using the ATP as an indicator for the microbial biomass. The results can be converted into carbon biomass or into the load in carbon biomass. The microbial decomposition of peptone in brackish water is similar to that occurring in fresh water, and the lag and log phases depend on the temperature. Laboratory analyses have shown that organic substances disturb the oxygen balance of a lake or a river, because they help dissimilation and inhibit assimilation. (Murphy-IVI)
W84-04909

EVALUATION OF CAIRO SEWAGE EFFLUENTS FOR IRRIGATION PURPOSES,
Ain Shams Univ., Cairo (Egypt). Dept. of Soils.
M. El-Nennah, and T. El-Kobbia.
Environmental Pollution (Series B), Vol. 5, No. 4, p 233-245, 1983. 2 Fig, 4 Tab, 17 Ref.

Descriptors: *Wastewater irrigation, *Wastewater treatment, *Sewage effluents, Irrigation practices, Irrigation water, Irrigation efficiency, Wastewater management, Wastewater disposal, Land disposal, Heavy metals, Wastewater composition.

Samples of Cairo sewage effluents were collected over a 1-year period from two treatment plants and analysed for pH, electrical conductivity (EC), soluble cations and anions, N, P and trace elements, i.e. B, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn. Cairo sewage effluents contained much higher concentrations of soluble salts and trace elements than did tap water. This difference was more marked in effluent after primary sedimentation in El-Gabal El-Asfar than after mechanical sedimentation in the El-Zeinin treatment plant. No detectable heavy metals were obtained without acidic digestion, indicating the association of these metals with suspended solids in sewage effluents. The evaluation of sewage effluents was made on the basis of combination of EC and both sodium adsorption ratio (SAR) and soluble sodium per cent (of total soluble cations) (SSP), boron concentration and maximum permissible limits of heavy metals in irrigation water. Both Cairo sewage effluents are suitable for irrigation after primary sedimentation in El-Gabal El-Asfar and mechanical sedimentation in El-Zeinin but the concentration of heavy metals in the effluents used in irrigation should be controlled. Also, attention should be focused on the accumulation of heavy metals in soils and plants. (Murphy-IVI)
W84-04940

WATER IN POLYMER MEMBRANES. PART I, WATER SORPTION AND REFRACTIVE INDEX OF CELLULOSE ACETATE,
Agricultural Research Service, Albany, CA. Western Regional Research Center
For primary bibliographic entry see Field 3A.
W84-05048

REVIEW OF WATER POLLUTION PROBLEMS AND CONTROL STRATEGIES IN THE SOUTH AFRICAN MINING INDUSTRY,
For primary bibliographic entry see Field 5B.
W84-05087

LIME TREATMENT OF ACID MINE WATER AND ASSOCIATED SOLIDS/LIQUID SEPARATION,
Anglo American Research Labs., Crown Mines (South Africa).
D. J. Bosman.
Water Science and Technology, Vol. 115, No. 2, p 71-84, 1983. 3 Fig, 4 Tab, 4 Ref.

Descriptors: *Acid mine drainage, *Lime, *Wastewater treatment, Sulfates, Pyrite Iron, Sludge, Calcium sulfate, Iron hydroxide, Scale, Flotation, Settling.

Mine waters become contaminated to a varying degree with the oxidation products of pyritic materials associated with the minerals. Waters containing from 6000 to 13000 mg/L of sulfates and up to almost 5000 mg/L of iron are reported. For practical or economical reasons it is not yet possible to prevent this contamination of mine water. Prevention of pollution of surface water in South Africa is mostly confined to the neutralization of acid mine water with lime. The neutralization reaction results in the precipitation of a voluminous sludge containing mostly iron hydroxide and calcium sulfate, when the latter is formed in excess of its solubility in water. The sludge usually settles to volumes equal to 10% of the volume of the water treated, but volumes as high as 50% have been found. Through application of the 'High Density Sludge' process, which comprises sludge recirculation and conditioning with lime in addition to conventional neutralization and sedimentation, the volume of these sludges has been reduced to 0.4-2.0% of the volume of water treated. The seeding of calcium sulfate resulting in a reduction of scale build-up on plant equipment seems to be an advantage of the process. Dissolved air flotation was found an attractive alternative means of solids/liquid separation to gravity settling for water producing relatively low amounts of sludge (100 to 200 mg solids/L). At hydraulic loadings of 7 cu m/sq m/h (seven times higher than gravity settling) the flotation process produced an effluent containing less than 15 mg/L suspended matter and a sludge with a density of 50 g/L. (Author's abstract)
W84-05089

USING LIME TREATED ACID MINE WATER FOR IRRIGATION,
Soil and Irrigation Research Inst., Pretoria (South Africa). Dept. of Agriculture and Fisheries.
H. M. du Plessis.
Water Science and Technology, Vol. 15, No. 2, p 145-154, 1983. 5 Fig, 3 Tab, 14 Ref.

Descriptors: *Wastewater irrigation, *Acid mine drainage, Lime, Wastewater treatment, Crop yield, Permeability coefficient, Salt, Sulfate, Water pollution prevention.

The disposal of acid sulfate mine water poses a universal problem. Although water quality is much improved when neutralized by lime treatment, high salt loads nevertheless make release to better quality surface streams undesirable. The feasibility of using such water for irrigation was evaluated using a steady state chemical equilibrium model to product the composition of water draining from successive soil segments under a range of leaching fractions. Large amounts of gypsum are expected to precipitate in the soil profile resulting in a greater reduction in salinity than would occur if the water contained chloride instead of sulfate. A comparatively smaller reduction in crop yields can thus be expected and a greater variety of the marginally salt sensitive crops can be grown. The precipitation of gypsum however results in an increased sodium hazard to soil physical properties. This does not appear serious when evaluated against published data on soil hydraulic conductivity as affected by sodium and electrolyte concentration. A drastic reduction in the salt load in drainage from irrigated land compared to that in the applied water is predicted. Irrigation with lime treated acid mine water does not only seem feasible but also advantageous for the protection of water resources from mineral pollution. (Author's abstract)
W84-05091

USING ACID MINE WATER FOR REMOVAL OF PHOSPHATES FROM SEWAGE EFFLUENT,
Germiston Municipality (South Africa). Engineer's Dept.
P. H. van der Merwe, J. P. Maree, and N. D. Basson.
Water Science and Technology, Vol. 15, No. 2, p 155-167, 1983. 6 Fig, 5 Tab, 10 Ref.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Acid mine drainage, Acidity, Nitrification, Iron, Chemical reactions, Ammonia, Economic aspects.

An experiment was conducted at the Rondebult sewage purification works, regarding the use of underground mine water with a high iron content (617 mg/l of iron) for phosphate removal from sewage effluents, to comply with a limit of 1 mg/l soluble orthophosphates in the effluent. Orthophosphate precipitation with hydrolyzing cations is pH dependent which can be attributed to the solubility of the precipitates which form and the competition that exists between the hydoxide and orthophosphate ions for reaction with the cations. During the experimental period the average ammonia value for the raw sewage was 30 mg/l as N. Progressive removal of phosphate was achieved through the primary and secondary process stages resulting in a final concentration of 0.7 mg/l as P. When about 30 mg/l of Fe was introduced, ammonia N levels dropped to the order 3 to 4 mg/l. A significant improvement in the COD removal was also noted. A removal of approximately 84% of the iron was achieved. No significant change in the

volume of the secondary sludge has been noted. The method is both practical and economically attractive as an alternative for the chemical removal of phosphates in sewage works effluent. (Baker-IVI)
W84-05092

DRIP IRRIGATION OF COTTON WITH TREATED MUNICIPAL EFFLUENTS: I. YIELD RESPONSE,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
H. Bielorai, I. Vaisman, and A. Feigin.
Journal of Environmental Quality, Vol. 13, No. 2, p 231-234, April-June, 1984. 2 Fig, 3 Tab, 11 Ref.

Descriptors: *Drip irrigation, *Cotton, *Wastewater irrigation, *Crop yield, *Israel, Effluents, Municipal wastewater, Plant growth, Fertilizers, Irrigation efficiency, Irrigation water.

A long-term drip irrigation experiment was conducted on a grumusol (Typic chromoxerent) soil at Zor'a, Israel in 1978, 1979, and 1980 to study the influence of municipal effluent on the growth, yield, and line quality of drip-irrigated cottom (Gossypium hirsutum L.) var. 'Acala SJ-2.' Two sources of irrigation water were used: (i) municipal effluent and (ii) fresh water. The N concentration in the effluent was about 50 mg/L during the 3 years of experimentation. The treatments included three seasonal amounts of effluent and fresh water application: 350, 440, 515 min; and five levels of N: 0, 90, 150, 180, and 230 kg/ha (average of the 3 years), added to the fresh water only, via the drip system. The cotton plants irrigated with effluent grew taller, with more vegetative growth than did the plants irrigated with fresh water. The seed cotton yield obtained in 1978 was relatively low as a result of excessive vegetative growth and lodging of the plants. In the 1978 season, the seed cotton yield averaged 4.35 and 4.04 Mg/ha for the effluent and freshwater treatments, respectively. When growth was retarded in the 1979 and 1980 seasons by delaying irrigation and adjusting fertilizer management, average yields increased to 4.95 and 4.57 Mg/ha for the two water qualities, respectively. Lint percentage was 39.0 and 40.2 for the effluent and freshwater treatments, respectively. The lint quality, as determined by strength, length, and micronaire was the same for cotton irrigated with effluent as for cotton irrigated with fresh water. Municipal effluent can be used effectively as a source of irrigation water and plant nutrients, and with appropriate management, high production can be obtained. Drip irrigation increases irrigation and fertilization efficiency and minimizes ecological hazards. (Author's abstract)
W84-05115

DRIP IRRIGATION OF COTTON WITH TREATED MUNICIPAL EFFLUENTS: II. NUTRIENT AVAILABILITY IN SOIL,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
A. Feigin, I. Vaisman, and H. Bielorai.
Journal of Environmental Quality, Vol. 13, No. 2, p 234-238, April-June, 1984. 5 Fig, 3 Tab, 16 Ref.

Descriptors: *Wastewater irrigation, *Drip irrigation, *Cotton, Effluents, Fertilizers, Nitrogen, Phosphorus, Potassium, Leaching, Municipal wastewater.

The suitability of sewage effluent for drip irrigation of cotton (Gossypium hirsutum) growing on a deep calcareous clay soil (Typic Chromoxererts) was studied during three seasons. Secondary effluent was compared with freshwater at three application rates, the average of which for the three seasons were: low (350 mm/yr), standard (440 mm/yr), and high (515 mm/yr). Fertilizer was applied with the fresh water in order to deliver amounts of nutrients (average for the 3 years) equivalent to those in the effluent that contained 150, 180, and 230 kg N; 32, 37, and 46 kg P; and 80, 100, 120 kg K/ha/yr for the three rates, respectively. In addition, the standard amount of fresh water was given with half the quantity of fertilizer, and without fertilizer. The concentration of available N and P in soil was increased greatly in all effluent and fertilizer-amended freshwater treatments, while available K in the soil was increased to a lesser extent. In general, at equivalent application levels, no significant differences in the level of available N, P, and K in the soil or in their uptake by plants, were detected between effluent and fertilizer-amended fresh water, although dry matter yield as well as N, P, and K accumulation were greater in the high-application-rate effluent treatment. The distribution of NO3-N in the soil profile was controlled by drip irrigation and practically no build-up of NO3(-) was detected below the 0- to 0.6-m depth layer during the irrigation period (in summer). However, during the rainy, winter season, heavy losses of residual NO3-N occurred probably mainly through leaching. (Author's abstract)
W84-05116

QUALITY OF PERCOLATE WATER AFTER TREATMENT OF A MUNICIPAL WASTEWATER EFFLUENT BY A CROP IRRIGATION SYSTEM,
Agricultural Research Service, St. Paul, MN.
D. R. Linden, C. E. Clapp, and W. E. Larson.
Journal of Environmental Quality, Vol. 13, No. 2, p 256-264, April-June, 1984. 8 Fig, 4 Tab, 26 Ref.

Descriptors: *Wastewater irrigation, *Land application, Wastewater renovation, Crop management, Corn, Grasses, Nitrogen removal, Phosphorus removal, Potassium, Sodium, Chloride, Percolating water.

Crop management effects on the renovation of municipal wastewater effluent were studied in a 6-year field experiment. A randomized split-plot block design was used, with corn (Zea mays L.) and forage grasses (reed canarygrass, Phalaris arundinacea L.) as crops and effluent application rates of none, approximately 0.05, and 0.10 m/week. Nitrogen, phosphorus, potassium, sodium, and chloride were measured in percolating soil water during 5 years under corn and 3 years under forage grasses to assess the quality of renovated wastewater. Nitrogen concentrations were generally below 10 mg/L, with total applications ranging between 200 and 970 kg N/ha/year. Nitrogen concentrations also were consistently lower under effluent treatments as compared with fertilized controls and lower under forage crops than under corn. Nitrogen levels increased significantly with increased application rates, especially under corn crops and only occasionally exceeded 10 mg/L during early and late season when applications surpassed crop uptake demands. Low P concentrations (< 0.05 mg/L) in percolate water verified nearly complete removal by the soilcrop system except during the final 2 years under corn when concentrations increased about fivefold to 0.7 mg/L. Potassium levels suggested a continuing removal from the effluent. Sodium and chloride concentrations began at low levels and increased during the first 1 to 2 years of irrigation until they approached the concentration of the effluent. These results indicate that high N demand crops such as forage grasses have the potential for better renovation of effluent than corn at high application rates, but at lower rates corn will renovate effluent to acceptable N concentrations. (Author's abstract)
W84-05119

PREDICTION OF PHOSPHATE MOVEMENT THROUGH SOME SELECTED SOILS,
Norsk Inst. for Skogforskning, Aas.
A. O. Stuanes, and C. G. Enfield.
Journal of Environmental Quality, Vol. 13, No. 2, p 317-320, April-June, 1984. 2 Fig, 3 Tab, 25 Ref.

Descriptors: *Phosphates, *Land disposal, *Soil water, *Solute transport, Soil chemistry, Mathematical models, Wastewater treatment, Sorption, Equilibrium isotherms.

The P sorption capacity of soils must be evaluated at land application wastewater sites when water quality criteria control the design of the treatment system. The soil's capacity to react with P is often underestimated when equilibrium isotherms are used to describe P sorption. An analytical one-dimensional convective dispersive solute transport model, assuming linear sorption and first-order irreversible precipitation, was evaluated to describe the movement of P in small laboratory columns. The model was calibrated to experimental data using nonlinear least squares analysis. The length of the column did not make a significant difference in the model coefficients. This finding suggests that the approximation of a linear sorption isotherm with first-order irreversible precipitation is adequate for making environmental assessments at land-treatment systems. Application of the model to the design of a land-treatment system would permit approximating a system life considering wastewater application rate, concentration of P in the applied water, and travel distance through the soil profile prior to discharge. Experimental data fit to a Langmuir equation using the same soils were found to seriously underestimate the capacity of soil to react with P. The same data fit to a Freundlich or other equilibrium isotherm would yield similar results. It was concluded that use of equilibrium isotherms without considering the kinetics of the reactions will lead to overly conservative designs of land application of wastewater treatment systems. (Author's abstract)
W84-05124

CHEMICAL ASPECTS OF THE LIME SEAWATER PROCESS,
Washington Univ., Seattle. Dept. of Civil Engineering.
J. F. Ferguson, and L. Vrale.
Journal of the Water Pollution Control Federation, Vol. 56, No. 4, p 355-363, April, 1984. 13 Fig, 3 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Clarification, *Lime, *Seawater, Hydrogen ion concentration, Coliforms, Phosphorus, Sludge.

The use of seawater makes lime treatment of wastewater more effective by improving suspended solids and phosphate removal. The lime seawater process is capable of producing an effluent suitable for marine discharge if no more than 75% soluble BOD removal is required. Removal of suspended solids and phosphorus is characterisically greater than 90%. The effluent is very clear. Seawater adds enough magnesium to precipitate at least 0.6 millimoles/L of magnesium hydroxide. The amount of seawater needed depends, therefore, on the solubility of magnesium hydroxide, which is a function of pH. As little as 1 to 2% seawater is needed if pH values above 11 are used; if pH values are below 1.5, 10% or more seawater will be required. Phosphate solubility is seldom limiting in the process, but can be described as a function of pH and calcium concentration. At pH values below 10.5, orthophosphate is a significant portion of the total phosphate. Sludge recycle improves the steady-state performance of the process. At lime dosages of 165 and 240 mg/L, effluent turbidity was reduced by 30 to 50% by sludge recirculation. (Baker-IVI)
W84-05142

ACCLIMATION OF ACTIVATED SLUDGE TO PENTACHLOROPHENOL,
Camp, Dresser and McKee, Inc., Annandale, VA.
G. T. Hickman, and J. T. Novak.
Journal of the Water Pollution Control Federation, Vol. 56, No. 4, p 364-368, April, 1984. 9 Fig, 13 Ref.

Descriptors: *Activated sludge process, *Acclimation, *Pentachlorophenol, Dextrose, Metabolism, Microorganisms, Toxicity, Shock loads, Priority pollutants.

The ability of activated sludge to withstand shock loads of priority pollutants was investigated. The degree of metabolic activity of the activated sludge was measured in terms of its specific rate of dextrose uptake. Almost a month was required for the municipal activated sludge to completely adjust to using dextrose. The apparent maximum specific uptake rate is roughly in the range of 0.30 to 0.35/hr. The SUR test was adequate to assess the inhibition of activated sludge. Introducing a low level of pentachlorophenol (PCP) to the activated sludge

process can offer protection from shock loads of PCP. The amount of protection afforded is directly related to the acclimation concentration. Acclimation of activated sludge to PCP also provides protection from shock loads of related priority pollutants. Complete removal of the introduced PCP was accomplished during the study, but was not maintained. The specific uptake rate procedure is a rapid, easy method of assessing the relative inhibition of toxic chemicals to activated sludge. (Baker-IVI)
W84-05143

PROCESS FOR THE REMOVAL OF ORGANIC HAZARDOUS MATERIAL FROM WASTE WATER (VERFAHREN ZUR ENTFERNUNG ORGANISCHER SCHADSTOFFE AUS ABWASSER),
Didier-Werke A.G., Konigswinter (Germany, F.R.).
H. Bender.
Wasserwirtschaft, Vol. 73, No. 3, p 71-75, 1983. 5 Fig.

Descriptors: *Wastewater treatment, *Organic matter, *Hazardous material, Heavy metals, Toxicity, Polymer resins, Water quality, Pollution load.

The efficient determination of heavy metals and organic matter in wastewater is necessary for an effective wastewater treatment process. The removal of toxic organic matter by adsorption to special polymer resins is presented as a new process. A degree of purity of less than 1 mg hazardous material per liter of treated waste water with a high specific pollution load can be achieved. The polymer resins and the process equipment allow various regeneration techniques. (Murhy-IVI)
W84-05234

GRADUAL DEVELOPING OF THE SEWAGE SYSTEM OF A CELLULOSE- AND PAPER-MILL AND FEEDBACK ON WATERQUALITY OF A RIVERSYSTEM (STUFENWEISER AUSBAU DER ABWASSERREINIGUNG EINER ZELLSTOFF-KARTONFABRIK UND SEINE RUCKWIRKUNG AUF DIE WASSERGUTE DER VORFLUTER),
Tuebingen Univ. (Germany, F.R.). Fakultaet fuer Biologie.
O. Klee.
Wasserwirtschaft, Vol. 73, No. 6, p 183-189, June, 1983. 10 Fig, 10 Ref.

Descriptors: *Wastewater management, *Water quality control, Industrial wastewater, Wastewater disposal, Wastewater facilities, Wastewater treatment.

In the span of 24 years wastewater treatment facilities have improved and so have treatment facilities of a cellulose- and paper mill. The Schussenstream along with its tributary, the Wolfegger Ach has had increased water quality in recent years. With the use of systematic sewage and effluent treatment by the local treatment plant the resulting effluent has improved so as to develop better water quality in the surrounding outfall areas. The development of improved treatment facilities was gradual but the results have warrented its implementation. (Murphy-IVI)
W84-05243

DIMENSIONING OF SURPLUS DISPOSAL WORKS WITH APPROXIMATION METHODS AND STORMWATER QUALITY MODELS (BEMESSUNG VON REGENENTLASTUNGEN MITTELS NAHERUNGSVERFAHREN UND SCHMUTZFRACHTMODELLRECHNUNGEN),
Bayerisches Staatsministerium des Innern, Munich (Germany, F.R.). Oberstem Baubehoerde.
A. Gottle, and H. Weis.
Wasserwirtschaft, Vol. 73, No. 9, p 298-303, 1983. 3 Fig, 8 Ref.

Descriptors: *Wastewater disposal, *Stormwater, *Model studies, Wastewater treatment, Water quality, Rainfall distribution, Sizing, Empirical methods, Deterministic methods.

Questions of the contamination of the receiving water and an optimized storm water treatment can be met only by means of quality models considering the real time series of the rainfalls as input. The design methods used in the procedure are compared. The methods can be divided into two groups: empirical methods, and deterministic measurement methods. The process of rainwater quality modeling for combined wastewater systems is dependent on deterministic methods. Empirical methods should not be incorporated in modelling processes. (Moore-IVI)
W84-05253

RHINE - PRIORITY FOR DRINKING WATER (AM RHEIN - VORRANG FUR TRINKWASSER),
K.-G. Malle.
Wasser, Luft und Betrieb, Vol. 27, No. 5, p 16, May 1983.

Descriptors: *Water quality standards, *Drinking water, *Rhine River, Water pollution effects, *Water pollution control, Conferences, Symposium, Water quality management.

The proceedings of the Ninth Conference of the International Study Group of Waterworks in the Rhine Catchment Area, held from 11 to 13 April 1983 in Cologne, Federal Republic of Germany, are briefly described. Focal point of the conference for drinking water experts was a discussion of problems with producers of wastewater discharge into the river. Modern column biology wastewater treatment facilities in Leverkusen and in the Wupper valley and the major municipal facility for Cologne in Stammheim were inspected. A panel discussion on the effectiveness of wasewater treatment facilities and future treatment goals included representatives of a municipal facility, the chemical and paper industries, and a waterworks facility. Subjects for discussion were furnished by Professor Sontheimer in his lecture 'Requirements for Wastewater Treatment in Light of New Developments in Rhine Water Quality.' He presented five theses: increased removal from the Rhine of matter that can be broken down easily by biological means is unnecessary (this was rejected as it was agreed that treatment of the lower Main and other polluted tributaries should continue); further removal of nitrogen and phosphorus compounds from wastewater has little significance for the Rhine (this met with strong protest from the Netherlands, while Sontheimer countered that concentrations low enough to reduce eutrophication in Netherlands lakes were impossible to achieve and suggested phosphate precipitation in lake inflows); group parameters like total organically bound sulfur rather than summed parameters or individual chemical analysis such as 5-day BOD which should be used to assess the quality of treated wastewater (it was agreed that all three have their place and that it would be a mistake to concentrate on a ever-increasing number of individual analyses); the immission rather than the emission situation is the deciding factor for drinking water quality, and adapting emission to water flow could be considered (water authorities disagreed, as their emphasis has been on emission); further development of wastewater treatment should concentrate on new methods rather than enlarging existing plants. (Gish-IVI)
W84-05272

HARDSHIP REGULATIONS OUTSIDE SECTION 9, PARAGRAPH 6 OF THE WASTEWATER TAX LAW (HARTEREGELUNGEN AUSSERHALB DES SEKTION 9 ABS. 6 ABWAG),
H. Keune.
Wasser, Luft und Betrieb, Vol. 27, No. 5, p 22-25, May 1983. 43 Ref.

Descriptors: *Wastewater tax law, *Water law, *Pollution taxes, Tax rate, Payment,.

The Federal Republic of Germany does not allow deductions to the user in cases of hardship. However, state laws do allow such applications for delay in payment and reductions in wastewater tax. A delay is permitted when immediate payment would result in severe hardship for the taxpayer and there would be no jeopardy to the authority's claim. Partial payment may be required for a tax cancellation, no appeal by the taxpayer is necessary. This usually occurs when it is obvious that payment cannot be made or when the cost of collection would be disproportionate to the amount collected. However, the tax claim is not deleted, and other measures against the taxpayer may be instituted. In one case of a tax reduction, part of the claim is deleted; this usually occurs if total payment would result in severe hardship, such as plant closure. Interest payments or late fines on wastewater taxes cannot be delayed or reduced. The states are obliged to refund taxes if a company pays too much; however there is no interest paid on the refund, so these should be avoided. Some states require prepayment of taxes, based on an estimate, the setting of one prepayment amount comes with the proviso that the estimate will be verified. As long as the proviso is in effect, the company may appeal the prepayment amount required. The authorities are legally bound to hear such appeals. The authorities are of the opinion that taxes should be paid on time even in the case of an appeal, but a Darmstadt court rejected this notion in 1982, so that taxes need not be paid until a decision is reached. Portions of the tax not in dispute should be paid to avoid interest payments. Money can be saved if a company informs the authorities when they expect a reduction in operation resulting in a reduction in wastewater discharged - as long as this will last at least 3 months with at least a 25% reduction in wastewater. In this case, taxes will be assessed on the new level of operation. (Gish-IVI)
W84-05273

MECHANICAL EXTRACTION DEVICES FOR MAXIMAL-LOAD ACTIVATED-SLUDGE STAGES (MASCHINELLE RAUMEINRICHTUNGEN FUR HOCHSTLASTBELEBUNGSSTUFEN),
L. Finkelmann.
Wasser, Luft und Betrieb, Vol. 27, No. 6, p 17-20, June 1983.

Descriptors: *Activated sludge process, *Wastewater treatment, *Mechanical extraction, *Pollution load, Activated sludge, Wastewater Renovation, Sludge conditioning, Sludge digestion, Sludge.

Multistage biological wastewater treatment facilities are gaining in importance, but are expensive to build and operate, so that ways to improve the cost:performance ratio are being sought. The use of a mechanical extractor to return activated sludge from the intermediate treatment stage to the activation tank is described in the case of the adsorption-activation procedure employed by the Rheinhausen and Rheinberg facilities, Federal Republic of Germany. After mechanical treatment, the wastewater enters a two-stage, and the second of which is the recycling, lowload stage. In the activation tank during the maximal-load stage, physical and biological adsorption and flocculation processes occur as well as biological degradation. In order to maintain maximal load (i.e., high nutrient supply), the amount of sludge is kept low by removing excess, while its load is kept high. The wastewater flows out around the perimeter of the activation tank into the ring-shaped intermediate treatment facility, where it is aerated and dewatered before activated sludge is returned to the second stage. Studies have shown that a fast return of activated sludge from the intermediate stage to the activation tank is important, and this can be achieved by means of a mechanical extractor that spans the entire basin and constantly circles. It is constructed as a double extractor with three underwater pumps on each side to convey sludge via two grooves on the extractor bridge back to the tank. Settled sludge is thereby removed in 20 min. In Rheinhausen, up to 720 cu m sludge/hr can be returned to the tank per groove. Advantages of this procedure are short total aeration time, low electricity use, full utilization of the cleansing power of the activated sludge, constant supply of

strongly activated sludge in the second biological stage, and stable, even performance. (Gish-IVI)
W84-05274

PREVENTION OF ORGANIC DEPOSITS AND MICROBIAL CONTROL IN INDUSTRIAL COOLING WATER SYSTEMS (VERHINDERUNG ORGANISCHER ABLAGERUNGEN UND MIKROBIELLE KONTROLLE IN INDUSTRIELLEN KUHLWASSERSYSTEMEN),
H. Schmidt.
Wasser, Luft und Betrieb, Vol. 27, No. 9, p 12-17, September 1983. 9 Fig, 9 Ref.

Descriptors: *Organic deposits, *Microbial control, *Cooling water, Industrial water, Water pollution control, Nuisance algae, Water quality control, Water pollution treatment, Chlorination, Biological wastewater treatment, Wastewater treatment, Pressure filters, Gravity filters.

The combined application of chlorine and biological dispersal agents (based on polyalkyl glycols) is effective in the control of microorganisms in industrial cooling water systems and is favorable both economically and ecologically. Such nonionic despersal agents allow effective penetration of chlorine in the form of hypochloric acid (HOCl), which is most effective as a free acid, so that water pH must be < 7.5. However, pH < 7 is to be avoided in order to prevent corrosion. Chlorine is applied in gas form directly to the water through a dosage device. Useful compounds are sodium hypochlorite and di- and tri-chlorine isocyanurate. In order to control the number of microorganisms in cooling water and to prevent deposits thereof that hinder heat transfer, continuous application of the biological dispersant at a concentration of 5-30 ppm (depending on system type, number of microorganisms and nutrient supply) is effective. This is combined with regular (1-3 times/day), discontinous application of Cl2 or NaOCl in an amount that causes a 0.5-1.0 ppm excess in free Cl2 in the cooling water return flow. Dispersant application is achieved by means of a dosage pump controlled by the volume of added water. To combat a preexisting infestation, the chlorine-dispersant combination is applied in alternating discontinuous doses in a concentration of up to 1,000 ppm dispersant. This concentration must be maintained for 24-72 hr, during which time sludge should be removed, beginning at a slow rate and then increasing. A more frequent backflushing of partial-flow filters will be necessary. This procedure can also be used to remove biomass from pressure and gravity filters. (Gish-IVI)
W84-05275

NOVEL METHOD FOR STUDYING THE PUBLIC HEALTH SIGNIFICANCE OF MACROINVERTEBRATES OCCURRING IN POTABLE WATER,
Worcester Polytechnic Inst., MA. Dept. of Biology and Biotechnology.
R. V. Levy, R. D. Cheetham, J. Davis, G. Winer, and F. L. Hart.
Applied and Environmental Microbiology, Vol. 47, No. 5, p 889-894, May, 1984. 6 Fig, 25 Ref. NIH grant RR07198-01, EPA grant CR810241-01-0.

Descriptors: *Macroinvertebrates, *Potable water, *Monitoring, Chlorine, Disinfection, Microbiological studies.

An experimental procedure was developed to study the association of selected bacteria and macroinvertebrates and their response to free available chlorine disinfection. The organisms selected for study were Escherichia coli (LacZ545), Enterobacter cloacae (ATCC23355), and the amphipod Hyalella azteca. E. coli was shown to bind tightly (16,000 CFU per amphipod) to this macroinvertebrate and to resist repeated attempts to wash it off. E. cloacae was shown to bind much less tightly (1,400 CFU per amphipod) to H. azteca and was less resistant to removal by washing. The extent of association is a function of macroinvertebrate size (surface area), but the procedure produces repeatable results usable for controlled experimentation. This method, together with the dual bacterial identification criteria (morphology and antibiotic resistance), was used to study the response of unassociated and associated E. coli and E. cloacae to disinfection with free available chlorine at 1.0 mg/liter. Unassociated E. coli populations decreased to less than 1% of their zero time controls within 1 min of contact time, whereas more than 2% of the associated E. coli populations remained viable after 60 min of contact at 1.0 mg of free available chlorine per liter. Unassociated E. cloacae populations decreased to less than 1% of their zero time controls within 1 min of contact time, whereas ca. 15% of the associated E. cloacae populations remained viable after 60 min of contact at 1.0 mg of free available chlorine per liter. With minor modifications this method can be used to study essentially any combination of bacterium and macroinvertebrate and to thereby ascertain whether a macroinvertebrate can serve to breach the chlorine disinfection barrier, protect potential bacterial pathogens from disinfection, and possibly allow for subsequent pathogen multiplication within a potable water distribution system. (Author's abstract)
W84-05276

REMOVAL OF ENTERIC VIRUSES FROM SURFACE WATER AT EIGHT WATERWORKS IN THE NETHERLANDS,
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
M. van Olphen, J. G. Kapsenberg, E. van de Baan, and W. A. Kroon.
Applied and Environmental Microbiology, Vol. 47, No. 5, p 927-932, May, 1984. 2 Fig, 3 Tab, 9 Ref.

Descriptors: *Enteric viruses, *Surfaces water, *Waterworks, *Netherlands, Microbiological studies, Water sampling, Water quality, Rhine River, River Drentse, River Meuse, Lake Haringvliet, Lake IJsselmeer, Bacteriophage, Bacterial analysis, Human enteroviruses.

Increased demands on surface water for the preparation of drinking water are combined with continuing pollution of these resources by sewage. Eight waterworks in The Netherlands, which use surface water as their raw water source, were sampled repeatedly between November 1978 and June 1981. Sampling took place on the Rhine River, River Drentse, River Meuse, Lake Haringvliet, Lake IJsselmeer and from surface water in Westland. At five waterworks, 30 of 45 samples of raw water contained viruses. Of 55 samples of partially purified water, 11 were virus positive, including 8 after coagulation, sedimentation, and rapid sand filtration, 2 after storage, coagulation, sedimentation, transport chlorination, and rapid sand filtration, and 1 after storage in open reservoirs for 5 months. No viruses were detected in 100 samples of drinking water of 500 liters each from six waterworks. Most isolated viruses were typed, and a great variety of human enteroviruses were found, reflecting both pollution of raw water sources with sewage and vaccination with oral polio vaccine in neighboring countries. (Murphy-IVI)
W84-05277

INFLUENCE OF WATER QUALITY ON ENTERIC VIRUS CONCENTRATION BY MICROPOROUS FILTER METHODS,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
M. D. Sobsey, and J. S. Glass.
Applied and Environmental Microbiology, Vol. 47, No. 5, p 956-960, May, 1984. 4 Tab, 18 Ref. EPA grant R806677.

Descriptors: *Enteroviruses, *Polioviruses, *Echoviruses, *Reoviruses, *Adenoviruses, *Water quality, *Filtration, *Microporous filters, Wastewater treatment, Biological properties.

Four enteric viruses, poliovirus type 1, echovirus type 1, reovirus type 3, and simian adenovirus SV-11, were concentrated from seeded 1.3-liter volumes of raw, finished, and granular activated carbon-treated waters by adsorption to 47-mm-diameter (17 sq cm), electropositive (Virosorb 1MDS) filters at pH 7.5 or electronegative (Filterite) filters at pH 3.5 with and without 5 mM added MgCl2, followed by elution with 0.3% beef extract in 50 mM glycine at pH 9.5. Removal of particulates from raw and finished waters by 0.2 micro m prefiltration before virus addition and pH adjustment had little effect on virus concentration efficiencies. Soluble organic compounds reduced virus adsorption efficiencies from both raw and finished waters compared with granular activated carbon-treated water, but the extent of interference varied with virus type and adsorption conditions. For electropositive 1MDS filters, organic interference was similar with all virus types. For Filterite filters, organic interference was evident with poliovirus and echovirus, but could be overcome by addig MgCl2. Reovirus and SV-11 were not adversely affected by organics during adsorption to Filterite filters. Elution of reovirus and adenovirus was inefficient compared with that of poliovirus and echovirus. None of the three adsorption schemes (1MDS at pH 7.5 and Filterite with and without 5 mM MgCl2 at pH 3.5) could be judged superior for all viruses and water types tested. (Author's abstract)
W84-05278

STUDIES OF THE HALOGENATION OF DISSOLVED ORGANIC MATERIAL DURING THE CHLORINATION OF SALINE COOLING WATERS, USING THE MODEL COMPOUND RESORCINOL,
Southampton Univ. (England). Dept. of Chemistry.
A. G. Howard, R. A. Pizzie, and J. W. Whitehouse.
Water Research, Vol. 18, No. 6, p 735-743, 1984. 6 Fig, 3 Tab, 36 Ref.

Descriptors: *Chlorination, *Saline water, Cooling waters, Resorcinol, Halogenation, Dissolved organic matter, Haloforms, Trihalomethanes, Bromide, Chemical reactions, Chlorine.

With a view to highlighting differences between the chlorination reactions occurring in fresh and marine waters, a study of halogenation reactions occurring during the chlorination of saline waters was undertaken. Chlorination of resorcinol in seawater with sodium hypochlorite resulted in the formation of 17 products. The variety of reaction products formed is controlled by competing equilibria involving chlorination of the resorcinol and conversion of oxidizing species to hypobromous acid by exchange with naturally occurring bromide. When bromide is present in a molar excess over added chlorine, chlorination of resorcinol is only favored under high pH conditions. Under more acid conditions however, bromination occurs at the expense of chlorination. Increasing chlorine levels leads to ring cleavage and the production of trihalomethanes, haloforms. (Baker-IVI)
W84-05320

AUTOTROPHIC NITRATE DISSIMILATION USING SODIUM THIOSULFATE (AUTOTROPHE NITRATDISSIMILATION DURCH EINSATZ VON NATRIUMTHOSULFAT),
Wasserwirtschaftsdirektion Saale-Werra, Halle (German D.R.).
H. Bohme, and D. Dieneck.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 160-163, May, 1983. 4 Fig, 1 Tab, 6 Ref.

Descriptors: *Nitrates, *Nitrogen removal, *Sodium thiosulfate, Drinking water, Water treatment, Chemical treatment, Water quality, Water quality control.

Experiments on the use of sodium thiosulfate to remove nitrate from drinking-water reservoirs in the German Democratic Republic (GDR) are described. Since 1960, nitrate levels in surface waters in the GDR have increased due to the intensification of agriculture. It was hoped that costs would be reduced by removing nitrates in the reservoir rather than by ion exchange at the water treatment plant. The autotrophic procedure was environmentally preferable to the heterotrophic, which requires the addition of carbon sources. Laboratory experiments were conducted to observe the auto-

trophic process and were used as a base for practical applications. One hundred tonnes (t) Na2S203.5H20 was introduced in two 50-t steps into the hypolimnion of an area of a drinking water reservoir in the GDR measuring 19.9 ha and with a volume of 3.1 million cu m (0.92 million cu m hypolimnion). The chemical was dissolved in a neighboring quarry and was introduced into the reservoir by means of a hose leading to a floating pipeline, which passed through a raft towed by a boat. A pump dispersed the chemical, diluted to 150 cu m/step, in 5-6 hr. Laboratory studies showed that nitrate dissimilation began only with oxygen levels of < 2 mg/l, so that a large portion of the first dose would be used to reduce oxygen levels. It was calculated that 9.22 t 02 had been removed by 35.7 to Na2S203.5H20, so that nitrate elimination began in earnest with the second application. A total of 16 t NO3(-) was transformed into elemental nitrogen. In late summer 1980, 450 t Na2S203.5H20 was introduced into an auxiliary reservoir of a GDR drinking-water reservoir with a volume of 23.1 million cu m (4.9 million cu m hypolimnion). A 30% solution of the chemical was prepared in a specially constructed tank and dispersed within 6 days in the hypolimnion by means of a 1,500-m pipeline, which snaked back and forth diagonally to the dam. A total of 10.8 t oxygen and 160 t NO3(-) was eliminated, demonstrating an overdosing of Na2S203.5H20 due to a previous heterotrophic NO3(-) procedure. The cost of the procedures using the latest technology is 2.23 Marks/kg NO3(-) eliminated, compared with 9-30 Marks/kg for the ion-exchange method. (Gish-IVI)
W85-04798

WATER CHEMISTRY AND THE ECONOMY OF RAW MATERIALS (WASSERCHEMIE UND STOFFWIRTSCHAFT),
Technische Univ., Dresden (German D.R.). Sektion Verabeitungs- und Verfahrenstechnik.
M. Schubert, and J. Kaeding.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 174-176, May, 1983. 2 Fig, 3 Ref.

Descriptors: *Water chemistry, *Optimum development plans, Water use, Water reuse, Water resources development, Energy, Wastewater treatment.

Efforts to optimize limited water resources in industrialized countries, particularly the German Democratic Republic (GDR), have led to wastewater-treatment techniques that concentrate on achieving high water quality in the receiving stream, whereby only the raw material water is subject to multiple use. Rational water use demands the reutilization of other raw materials. Recently the Socialist Unity Party of Germany called for the creation of closed cycles for raw materials, and both COMECON and the UN have recommended development of a 'garbage (waste-product)-free technology.' However, it is not enough to institute recycling within an individual product line; the concept must be carried over into all industrial and consumer areas. The goal of such an economy is the mutual exchange of energy and raw materials between society and the environment. For municipal wastewater, this might include the concepts of wastewater as raw material (sludge used for chemical synthesis, reclamation of nutrients like phosphorus, use of organic dry matter as soil conditioner); direct energy gain (by installing a heat pump at the outlet of a wastewater facility, thermal energy released in biochemical metabolism); energy conservation at the treatment plant through improved aeration for the activated-sludge procedure and substitution of anaerobic for aerobic treatment; and metabolic procedures to create new forms of energy (methane gas production by sludge and surface-water digestion, wet oxidation and incineration/pyrolysis of biological sludge). Collection of comprehensive data on wastewater through water chemistry, introduction of new types of bacteria through hydrobiology, and research into new wastewater-treatment techniques are essential, as is the education of scientists and engineers in the closed-cycle principle. The GDR, together with the Hungarian Peoples Republic, prepared a handbook on waste-product-free technology for the UN to aid in the evaluation of such procedures. Such international cooperation is considered important in the peace policy of socialist countries. (Gish-IVI)
W85-04802

5E. Ultimate Disposal Of Wastes

METHODOLOGIES TO PREDICT THE MOBILITY AND AVAILABILITY OF HAZARDOUS METALS IN SLUDGE-AMENDED SOILS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W84-04886

LAND USE OF WASTEWATER AND SLUDGE,
Nolte (George S.) and Associates, Sacramento, CA.
R. W. Crites.
Environmental Science and Technology, Vol. 18, No. 5 p 140A-147A, May, 1984. 2 Fig, 4 Tab, 49 Ref.

Descriptors: *Municipal wastewater, *Land application, Public health, Sludge disposal, Spray irrigation, Wastewater treatment, Trace metals, Phosphorus, Nitrification, Biochemical oxygen demand, Infiltration, Soil properties, Reviews, Suspended solids.

A review of current technologies, treatment performance, and research needs for the use of municipal wastes is offered. The three land treatment processes for wastewater are slow rate, rapid infiltration, and overland flow. Slow rate land treatment is the controlled application of wastewater by sprinkler or surface means to a vegetated land surface. Rapid infiltration is the application of wastewater to permeable soils, such as sands or sandy loams, for treatment in shallow spreading basins. Overland flow is a fixed-film biological treatment process by which wastewater is applied at the upper portions of grass-covered slopes and allowed to flow down the slope to runoff collection ditches. Land treatment processes are very efficient in removing biodegradable organics and suspended solids. Both the slow rate and the rapid infiltration processes remove phosphorus from applied wastewater very efficiently. Overland flow is less efficient because of the limited contact between the wastewater and the adsorption sites within the soil. Removal of pathogenic organisms is accomplished by filtration, adsorption, desiccation, radiation, predation, and exposure to other adverse conditions. Trace organics are removed by adsorption, biodegradation, photodecomposition, and volatilization. Trace elements removal involves adsorption, precipitation, ion exchange, and complexation. Research needs for land treatment of municipal wastewater include hydraulic aspects of soil systems and prediction of process performance, preapplication treatment and crop management. Sludge use issues continue to center on the public health concerns over cadmium, lead, toxic organics, and pathogens. (Baker-IVI)
W84-04889

MATRIX DIFFUSION EFFECTS ON CONTAMINANT MIGRATION FROM AN INJECTION WELL IN FRACTURED SANDSTONE,
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 5B.
W84-05106

LAND TREATMENT OF CONTAMINATED SLUDGE WITH WASTEWATER IRRIGATION,
Muskegon County Wastewater Management System, MI.
Y. A. Demirjian, T. R. Westman, A. M. Joshi, D. J. Rop, and R. V. Buhl.
Journal of the Water Pollution Control Federation, Vol. 56, No. 4, p 370-377, April, 1984. 1 Fig, 11 Tab, 14 Ref.

Descriptors: *Sludge, *Land disposal, *Wastewater irrigation, Heavy metals, Zinc, Dichloroazobenzene, Chloroaniline, Crop yield, Plant growth, Organic compounds, Priority pollutants.

The fate of organic priority pollutants and additional man-made organics in sludge applied to wastewater-irrigated soils was investigated. Heavy metals were also monitored to determine their behavior under these conditions. The nutritive value of the sludge and the corresponding yield increases were not considered. Thirteen priority pollutants and seventeen additional organic compounds were present in the sludge which was applied at a rate of 40,333 Kg dry sludge/ha. Most of the organic compounds degraded, with the exception of 2,2'-dichloroazobenzene, which may have been mainly introduced through past irrigations. There is a possibility that microbial transformation of 2-chloroaniline could generate the 2,2'-dichloroazobenzene. Because of this it may be helpful to apply 2-chloroaniline to a virgin field. However, none of the intermediates in the microbial conversion of 2-chloroaniline and 2,2'-dichloroazobenzene were detected. Build up of metals in the soil was minimal. Zinc concentration increased slightly in the groundwater, but at least 50% of this could be related to either present or past irrigations. The corn grown on the sludge application area was chemically no different than that grown on the background area, only apparently healthier. (Baker-IVI)
W84-05144

5F. Water Treatment and Quality Alteration

WATER SUPPLY MANAGEMENT ENTERS A NEW ERA,
Raub (Jack G.), Mission Viejo, CA.
For primary bibliographic entry see Field 6A.
W84-04922

DIHALOACETONITRILES IN DRINKING WATER: ALGAE AND FULVIC ACID AS PRECURSORS,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
For primary bibliographic entry see Field 5B.
W84-04943

MANAGING WATER QUALITY BY MIXING WATER FROM DIFFERENT SOURCES,
Hawaii Univ., Honolulu. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3C.
W84-04955

CHEMICAL CHANGES OF ORGANIC COMPOUNDS IN CHLORINATED WATER; IX. FORMATION OF POLYCHLORINATED PHENOXYPHENOLS DURING THE REACTION OF PHENOL WITH HYPOCHLORITE IN DILUTE AQUEOUS SOLUTION,
Tokyo Univ. (Japan). Faculty of Pharmaceutical Sciences.
S. Onodera, K. Yamada, Y. Yamaji, and S. Ishikura.
Journal of Chromatography, Vol. 288, No. 1, p 91-100, April, 1984. 6 Fig, 2 Tab, 18 Ref.

Descriptors: *Chlorinated hydrocarbons, *Chlorination, *Phenols, *Hypochlorite, Water treatment, Chlorinated phenoxyphenols, Hydrogen ion concentration.

Aqueous phenol solutions were treated with hypochlorite at 20 degrees C under various experimental conditions. Changes in the composition of the chlorination products in water were determined by using gas chromatographic (GC) and GC-mass spectrometric analyses of diethyl ether extracts. Chlorination of phenol in dilute aqueous solution produced a series of highly chlorinated compounds, including chlorophenols, chlorobenzoquinones and chlorinated carboxylic acids. Tentative identifications were also made for other compounds with the following proposed molecular formulae: C12H8Cl2O2, C12H7Cl3O2, C12H6Cl4O2 and C12H5Cl5O2. On the basis of thin-layer chromatographic and GC behavior, these compounds are considered to be chlorinated

phenoxyphenols. Production of some of these compounds is dependent on the equivalents of chlorine per mole of compound and the reaction pH. These results show that treatment with chlorine of water contaminated with phenolic compounds leads to the production of chlorinated phenoxyphenols. (Author's abstract)
W84-05125

CONTROL OF ALGAE BY CHEMICAL TREATMENT IN A EUTROPHIC WATER SUPPLY RESERVOIR,
Essex Univ., Colchester (England).
C. R. Hayes, R. G. Clark, R. F. Stent, and C. J. Redshaw.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 2, p 149-162, April, 1984. 6 Fig, 1 Tab, 17 Ref.

Descriptors: *Eutrophication, *Reservoirs, *Algal control, Phosphates, Ferric sulfate, Sediments, Aeration, Chemical reactions, Algal growth, Water treatment.

There have been problems with eutrophication at the Foxcote reservoir, in England. Algal control in eutrophic public water supply reservoirs can be achieved by limiting the availability of the nutrient phosphate. The internal recycling of phosphate from reduced sediments is antagonistic to this objective. Control of soluble phosphate in the pumped river inflow to Foxcote reservoir at concentrations of up to 0.75 mg/l (P) has been achieved by ferric sulfate dosing at doses ranging from 3 to 5.4 mg/l (Fe). Short-term algal control can be achieved by ferric sulfate dressing. No residual iron or acidity problems were experienced. There is a need to optimize the method of application. Ferris floc deposited on the reservoir bottom can have a modifying influence on the chemistry of the surface sediment, but this does not yet appear to have been of significance at Foxcote except in the localized inflow area. The cost of ferric sulfate dosing is offset by reductions in the chemical requirements of water supply treatment to give an annual average net cost of 0.15 p/cu m. Control options for reducing internal recycling of phosphate include aeration and the removal of phosphate rich sediments; both could incur substantially greater cost than the current chemical treatment. These options may not be necessary, however, if internal recycling diminishes as a result of external loading control and reduced reservoir productivity. (Baker-IVI)
W84-05138

DISINFECTION OF DRINKING WATER BY ULTRAVIOLET LIGHT,
Severn-Trent Water Authority (England).
N. H. Groocock.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 2, p 163-172, April, 1984. 2 Fig, 1 Tab, 20 Ref.

Descriptors: *Drinking water, *Disinfection, *Ultraviolet radiation, Water treatment, Bacteria, Turbidity, Reviews.

The state of the art of water disinfection through the use of ultraviolet light (UV) is reviewed. Topics discussed include the principles of the production of ultraviolet light, apparatus for the production of UV radiation (low and medium presure vapor lamps), factors affecting germicidal efficiency, monitoring germicidal efficiency, dosages for the inactivation of various organisms, requirements and operation of UV units, comparison of the advantages and disadvantages of UV treatment with chemical disinfection methods, and other uses of UV in related circumstances. UV radiation can be successfully used for water disinfection if the units are correctly sized and maintained and sufficient monitoring and control devices are incorporated. Alternatives should be sought, however, for highly polluted sources or those subject to poor UV transmission characteristics or variable turbidity, unless sufficient suitable, preliminary treatment can be incorporated. The process is particularly suitable for small water supplies to remote areas. (Baker-IVI)
W84-05139

TE MARUA WATER STORAGE PROJECT; WELLINGTON REGIONAL COUNCIL, NEW ZEALAND,
M. D. Palmer.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 2, p 173-176, April, 1984. 2 Fig.

Descriptors: *Storage reservoirs, *Water supply development, *Wellington, *New Zealand, Karori, Water storage, Water treatment.

The Te Marua storage project has been devised to provide significant additional storage of water for supplying the city of Wellington, New Zealand. Treatment is to be a conventional flocculator, bimedium rapid gravity filter with on site storage for backwash water and terminal storage for filtered water. The source is a clear slightly acid upland water which presently receives no treatment other than chlorination. The storage scheme with treatment capability will permit use of the source at all river stages which is not possible at present due to increased turbidity under storm run-off conditions. In operation, water will be passed into supply by gravity via a new purification plant on the same site, any surplus Kaitoke water overflowing into the water storage lakes. (Baker-IVI)
W84-05140

MUNICIPALITIES ACT TO SUPPLEMENT DWINDLING GROUNDWATER SUPPLIES,
G. Mahoney.
Public Works, Vol. 115, No. 5, p 84-85, May, 1984. 1 Fig.

Descriptors: *Water supply development, *Water conveyance, *Lake Michigan, *Chicago, Pipelines, Water treatment, Cost analysis.

A $335 million project to purchase and pipe treated water from Lake Michigan to the far western suburbs of Chicago will include constructing about 140 miles of mains, creating 90 million gallons of storage capacity in six locations, and two large pumping stations. Currently involved in the new project are 22 of the 34 municipalities in Du Page County. The water supply system will start with a connection to Chicago's Central Tunnel System at the Central Park Avenue pumping station on the near west side of the city. The lake water is less hard than the groundwater currently used and will not require softening. Costs of installing and maintaining wells will be eliminated and system maintenance expenses, such as corrosion prevention, will be reduced. (Baker-IVI)
W84-05150

EFFICIENT TELECONTROL IN WATER MANAGEMENT (KOSTENGUNSTIGE FERNWIRKTECHNIK IN DER WASSERWIRTSCHAFT),
Vollmar G.m.b.H., Stuttgart (Germany, F.R.).
H. Fahrner.
Wasserwirtschaft, Vol. 73, No. 3, p 76-86, March, 1983. 7 Fig, 3 Tab, 39 Ref.

Descriptors: *Telecontrol, *Water supply systems, Water management, Water control, Optimization, Operating costs, Capital costs.

Telecontrol in the water supply industry mostly works through private communication cable systems or leased circuits. Therefore the capital expenses and operating expenses are very high when traversing great distances. By the use of public networks of the post (telefon network and datexnet) a considerable savings in capital expenses and operating expenses could be experienced. (Murphy-IVI)
W84-05235

PUBLIC WATER SUPPLY AS SPHERE OF ECONOMIC ACTIVITY OF THE LOCAL AUTHORITIES (DIE OFFENTLICHE WASSERVERSORGUNG ALS WIRTSCHAFTLICHES BETATIGUNGSFELD DER GEMEINDEN),
Zweckverband Landeswasserversorgung, Stuttgart (Germany, F.R.).
E. Muller.
Wasserwirtschaft, Vol. 73, No. 7/8, p 216-220, 1983. 6 Tab, 5 Ref.

Descriptors: *West Germany, *Bad-Wurttemberg, *Water supply, *Utilities, *Legal aspects, Economic aspects.

More than 96% of the population of the Federal Republic of Germany get their drinking water from public water supplies. These waterworks are operated by the local authorities. The legal obligations imposed upon the local authorities in Baden-Wurttemberg by virtue of their responsibility for this task as well as their legal status are reviewed. (Author's abstract)
W84-05245

NORWALK GASTROENTERITIS ASSOCIATED WITH A WATER SYSTEM IN A RURAL GEORGIA COMMUNITY,
Georgia Dept. of Human Resources, Atlanta. Office of Epidemiology.
For primary bibliographic entry see Field 5C.
W84-05284

5G. Water Quality Control

NEW TECHNOLOGY FOR NUTRIENT PRECIPITATION IN LAKES (EINE NEUE TECHNOLOGIE ZUR NAHRSTOFFALLUNG IN SEEN),
Wasserwirtschaftsdirektion Kueste, Neubrandenburg (German, D.R.).
E. Penz, and W. Dolgner.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 158-159, May, 1983. 2 Tab, 3 Ref.

Descriptors: *Aluminum sulfate, *Lake restoration, *Triensee, *East Germany, Flocculation, Phosphate removal, Ice cover, Nutrients, Phytoplankton, Hydrogen ion concentration.

Aluminum sulfate, Al2(SO4)3, was used to precipitate phosphate in the Triensee, a lake covering 1.5 ha and with an average depth of 2.5 m, near Murchin, German Democratic Republic. The small, shallow lake with unstable stratification contains one deep (5.5 m maximum) area surrounded by muddy shallows with phosphate-rich sediment. A larger dosage than is usual for lakes (4 tonnes Al2(SO4)3) was chosen to seal the phosphate in sediment and to overcome the lake's strong circulation with its sediment displacement. The agent was spread manually on the lake's ice cover on March 3, 1981; this represented a new technology. A favorable time for nutrient precipitation (pregrowing season spring total circulation) was artificially created, since the aluminum sulfate triggered a quick ice-melt. Contact between the granulated precipitating agent and the ice caused a highly concentrated solution, which precipitated dissolved orthophosphate evenly and effectively. No expensive flocculation aids were needed. The method can be used for all types of surface waters without high expenses. On March 9, 1981, the lake bottom was visible, and flocks were evenly distributed over the sediment. Microscopic examination showed that almost all phytoplankton were contained in the flocks. Orthophosphate could not be found, and 5-day BOD and COD were reduced by 5.0%. The lake has remained oligotrophic. However, a pH decrease to 4.8 occurred, and the lake was acid until August. (Gish-IVI)
W84-04797

PLUME DILUTION FOR DIFFUSERS WITH MULTIPORT RISERS,
California Inst. of Tech., Pasadena. W.M. Keck Lab. of Engineering Materials.
For primary bibliographic entry see Field 8B.
W84-04829

BAG EXPERIMENTS ON THE EFFECT OF PHOSPHORUS AND BASE ADDITIONS ON THE ALGAL BIOMASS AND SPECIES COMPOSITION OF AN ACID LAKE,
West Virginia Univ., Morgantown. Dept. of Biology.
G. R. Wilcox, and J. DeCosta.

Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 2, p 173-199, 1984. 15 Fig, 16 Tab, 33 Ref.

Descriptors: *Phytoplankton, *Phosphorus, *Acid lakes, *Bases, Acidity, Algal growth, Neutralization, Acidic water, Nutrients, Chlorophyll, Biomass, Lake restoration.

Bag experiments were performed during the summer of 1976 to determine the effect of nutrient and base addition on the algal biomass and species composition of an acidic lake. In one study, phosphorus (10 microg/l) was added alone and in combination with a base addition (NaOH) which raised the pH to 8.0-8.3. Other treatments included base addition alone and a control treatment in which neither nutrient nor base was added. In treatment 4, the experimental design was as above except that on day 12, base was added to the phosphorus treatment, phosphorus was added to the base treatment and acid was added to the phosphorus plus base treatment. Uncorrected chlorophyll a concentrations were greatest in the phosphorus plus base treatments which were greater than the concentrations in either the lake (sampled at surface and 1 meter depths), control, or base treatments. Base addition alone did not increase algal biomass compared to the lake and control treatments. Phosphorus plus base additions had notable growth lag times ranging from 6 to 10 days before greater chlorophyll concentrations were achieved. Base additions alone resulted in the reduction of the nannoplankton contribution to the total phytoplankton cell volume. Phosphorus and phosphorus plus base additions resulted in a nannoplankton dominance. The phosphorus plus base treatments became dominated by Chlorella sp., Scenedesmus quadricauda, and Ankistrodesmus falcatus. The dominant phytoplankton species present in the lake during these experiments were Peridinium inconspicuum, Dinobryon divergens, Botryococcus braunii, and Chlorella sp. (Baker-IVI)
W84-05013

SPECIATION: AN ESSENTIAL TOOL FOR THE ENVIRONMENTAL CONTROL OF INORGANIC CHEMICALS IN WATER,
Greenblatt, Greenblatt and Risenburger, Vineland, NJ.
F. J. Riesenburger.
Columbia Journal of Environmental Law, Vol. 9, No. 1, p 63-74, 1983. 1 Fig, 41 Ref.

Descriptors: *Speciation, *Pollutant identification, Wastewater treatment, Water analysis, Legislation, Monitoring, Water pollution control.

The speciation procedures described make it possible to qualitatively analyze compound forms and to quantify each different compound form. By accurately determining the water sites actually contaminated by the most hazardous inorganic or organic compound forms of an element, speciation could lead to a more effective allocation of funds for environmental control programs. Significant improvement of the environment by the use of speciation could also take place in other ways. Treatment methods implemented at existing water treatment plants are generally formulated on the basis of traditional bench scale analyses. Speciation could make possible the identification of certain compound forms which may not be responding optimally to such treatment methods. Introduction of a pretreatment or final polishing stage specifically addressed to the isolated problem compound form should increase significantly the efficiency of water treatment plants. Speciation could also provide a useful tool for the identification of the processors of certain chemicals found in surface waters, abandoned repositories and midnight dump sites. The EPA is currently reassessing the National Interim Primary Drinking Water Regulations, as the first step in the process of issuing new National Revised Primary Drinking Water Regulations. It is recommended that speciation be recognized by and incorporated into those regulations. (Baker-IVI)
W84-05046

RAPID DRAINAGE OF COAL SEAMS FOR PREVENTION OF ACID FORMATION,
R. B. Watson.
Water Science and Technology, Vol. 15, No. 2, p 103-114, 1983. 6 Fig, 2 Tab.

Descriptors: *Coal mining, *Acid mine drainage, Mine wastes, Boreholes, Drainage, Water pollution control, Adits.

The drainage of mineralized water from both operating and abandoned coal mines is a problem and clearly constitutes a serious source of stream pollution in the coal fields. The degree of acidity in mine drainage water can be reduced by removing the water from a mine as soon as practically possible. Coal extraction methods being used in South Africa are reviewed along with a study of the formation of acid mine water and drainage methods employed, which do provide some degree of success in the limitation of the acid content of the resultant mine drainage. Methods discussed include pumping (a common method of water removal which can be costly due to the corrosiveness of the waters being pumped), drainage adits (the method used being to drive a tunnel from below the coal seam outcrop to a point beneath the water accumulation), and borehole drainage systems. Success with drainage adits, properly planned and installed, has been promising for the rapid drainage of water from the workings of coal mines. The means by which drainage is effected from a mine will depend largely on the circumstances of the mine. Factors such as depth, mining method, quantity of water and whether or not acidity is likely to occur, have a bearing on the decision. (Baker-IVI)
W84-05090

ASSESSMENT OF THE EFFECTIVENESS OF BARRIERS FOR THE RETARDATION OF POLLUTANT MIGRATION,
Oklahoma Univ., Norman, Environmental and Ground Water Inst.
R. C. Knox.
Ground Water, Vol. 22, No. 3, p 279-284, May-June, 1984. 8 Fig, 3 Ref.

Descriptors: *Barriers, *Water pollution control, *Groundwater protection, Model studies, Path of pollutants, Mathematical models, Solute transport.

The analysis of the movement of contaminated ground water under or through an imperfect barrier is presented. The first phase of the analysis consists of the development of an analytical solution for the flow of ground water under a barrier and a simple numerical integration technique for developing concentration breakthrough curves. This simple solution algorithm was applied to the cases of variable recharge rates and lengths, variable depths of penetration of the barrier, and anisotropic soils. The second phase of the analysis involves applying a numerical solute transport model to analyze the performance of a barrier with and without the effects of hydrodynamic dispersion, and in the presence of a layered soil, and finally the performance of a fully penetrating but partially permeable barrier. The most efficient use of barrier technology appears to be placement of the barrier directly adjacent to the source of contaminated recharge. Unless a perfect connection can be made between the barrier and the underlying impermeable formation, the barrier does not provide complete containment. The barrier will provide an initial time lag before the appearance and increase in concentration of a contaminant under the barrier. When an aquifer with a waste source is highly conductive in the vertical direction, the effectiveness of a barrier is practically negligible. The numerical model and analysis employed was relatively simple, quick, and economical. (Baker-IVI)
W84-05103

MONITORING AND MATHEMATICAL MODELING OF CONTAMINATED GROUNDWATER PLUMES IN FLUVIAL ENVIRONMENTS,
Idaho Univ., Moscow. Coll. of Mines and Earth Resources.
J. L. Osiensky, G. V. Winter, and R. E. Williams.
Ground Water, Vol. 22, No. 3, p 298-306, May-June, 1984. 9 Fig, 1 Tab, 9 Ref.

Descriptors: *Groundwater pollution, *Monitoring, *Mathematical models, Monitoring wells, Sediments, Permeability, Channels, Streams, Fluvial environments, Plumes, Hydrogeology.

Groundwater monitoring to delineate a contaminant plume in fluvial hydrostratigraphic units often is uncertain. Hydrostratigraphic units deposited in fluvial environments consist typically of interbedded layers of sands, silts and clays, with sinuous buried stream channel deposits of sands or gravels. Failure on the part of investigators to understand the depositional environment that formed the hydrostratigraphic units may result in ineffective monitor well networks as the significance of buried stream channels may be overlooked. The results of mathematical modeling and the case history show that contaminants may migrate preferentially around monitor wells located immediately down gradient of the contaminant source. Awareness by investigating hydrogeologists as to the existence of buried stream channels is critical to optimal monitor well field design and correct interpretation of the resulting water quality data. (Baker-IVI)
W84-05105

GROUND-WATER QUALITY AT A CREOSOTE WASTE SITE,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
P. B. Bedient, A. C. Rodgers, T. C. Bouvette, M. B. Tomson, and T. H. Wang.
Ground Water, Vol. 22, No. 3, p 318-329, May-June, 1984. 6 Fig, 6 Tab, 22 Ref.

Descriptors: *Groundwater pollution, *Water quality control, *Monitoring, *Contore, *Texas, Wells, Creosote, Path of pollutants, Microorganisms, Organic compounds, Groundwater movement, Chlorides, Permeability, Hydraulic gradient.

An abandoned creosote facility in Contore, Texas has become a field site for a groundwater quality study. Groundwater contamination in the shallow aquifer beneath the site was characterized by sampling soils and water quality at 14 monitoring wells and 35 boreholes. An observed chloride and trace level organic plume of groundwater contamination exists up to 300 ft (91.5 m) from the pit locations. Background chloride concentrations of 15 mg/l are exceeded in all of the wells in the pit area. Naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, dibenzofuran, and fluorene have the highest concentrations in specific wells. A groundwater flow net has been determined from water level measurements indicating that the groundwater is moving in a south and southwest direction with some convergence of flow near well number 1. Hydraulic conductivity values from field tests were used with a hydraulic gradient established from water table contours in the flow net to predict a groundwater seepage velocity of 4 ft/yr to about 10 ft/yr. Several wells exist in the general flow direction, but not directly down gradient from the waste pit locations. Microbial studies show that soil microbe populations do exist that are capable of degrading selected organics. The subsurface has not been penetrated beyond 44 ft in well 1 where 5 ft of clay was encountered. The shallow contaminated water is not being used as a drinking water supply. (Baker-IVI)
W84-05107

SYRINGE AND CARTRIDGE METHOD FOR DOWN-HOLE SAMPLING FOR TRACE ORGANICS IN GROUND WATER,
Oregon Graduate Center, Beaverton. Dept. of Chemical, Biological, and Environmental Sciences.
J. F. Pankow, L. M. Isabelle, J. P. Hewetson, and J. A. Cherry.
Ground Water, Vol. 22, No. 3, p 330-339, May-June, 1984. 3 Fig, 1 Tab, 32 Ref.

Descriptors: *Groundwater pollution, *Sampling, *Monitoring, *Organic compounds, Burlington, Ontario, Boreholes, Piezometers, Measuring instruments.

A newly developed technique which allows the downhole sampling and subsequent analysis of groundwater for trace organic contaminants was tested during an investigation of contaminant mi-

gration at an inactive landfill site in Burlington, Ontario. The technique is based on the analytical method adsorption/thermal desorption and analysis by GC/MS/DS and has been developed for the determination of microg/l levels of organic contaminants in groundwater. The convenience of the technique for field use and the reproducibility of the results were encouraging. The technique enables samples to be obtained from any depth in piezometers or wells in a manner that minimizes losses due to volatilization and sorption on sampling equipment. Each cartridge is a dedicated sampler in that it is not used in more than one piezometer or well. Because the sample exists as a small, lightweight, porous cartridge regardless of the water volume that is sampled, the sample is in a form that is very convenient for packaging and shipping by mail or by air courier between field sites and distant analytical laboratories. (Baker-IVI)
W84-05108

NITRATE LEACHING AS INFLUENCED BY WATER APPLICATION LEVEL AND NITRIFICATION INHIBITORS,
Agricultural Research Service, Ames, IA.
D. R. Timmons.
Journal of Environmental Quality, Vol. 13, No. 2, p 305-309, April-June, 1984. 4 Fig, 4 Tab, 19 Ref.

Descriptors: *Nitrates, *Irrigation practices, *Nitrification inhibitors, Nonpoint pollution sources, Leaching, Water pollution sources, Nitrapyrin, Terrazole, Groundwater pollution, Fertilizers, Supplemental irrigation.

The effects of water application level and nitrification inhibitors on NO3-N leaching from a sandy loam soil were evaluated using soil columns and nonweighing field lysimeters. In soil columns (297 mm diam. by 1.2 m deep) fertilized with 224 kg N/ha, addition of the nitrification inhibitor nitrapyrin (2-chloro-6(trichloromethyl)pyridine) reduced NO3-N leaching losses by 51 and 30 kg/ha, respectively, for the 12.7- and 38.1-mm weekly water application levels. Both nitrapyrin and Terrazole (5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole) inhibitors were equally effective in reducing total NO3-N leaching losses from soil columns after 100 d for the 38.1-mm water application level. The change in flow-weighted NO3-N concentration due to use of nitrification inhibitors was about -0.4 to -1.0 mmol/L. Annual NO3-N leaching losses measured at the 1.2-m depth in field lysimeters cropped with corn (Zea mays L.) over a 3-yr period averaged about 12 kg/ha less (7%) for nitrapyrin-coated urea. The results were not consistent since nitrapyrin reduced NO3-N leaching during the growing season by 12 and 17% for 2 of the 3 yr and post season leaching by 35% for 1 yr. The change in flow-weighted NO3-N concentration (3-yr avg) due to nitrapyrin was -0.4, -1.5, and +0.9 mmol/L, respectively, for the growing season, post season, and pre-emergence periods. Nitrification inhibitors may help to minimize nonpoint-source pollution on sandy soil where supplemental irrigation is used by reducing and/or delaying NO3-N leaching particularly during the growing season when N is utilized by plants. (Author's abstract)
W84-05122

CONTROL OF ALGAE BY CHEMICAL TREATMENT IN A EUTROPHIC WATER SUPPLY RESERVOIR,
Essex Univ., Colchester (England).
For primary bibliographic entry see Field 5F.
W84-05138

HYDROTURBINE VENTING FOR DISCHARGE OXYGENATION,
Tennessee Valley Authority, Norris.
For primary bibliographic entry see Field 8C.
W84-05147

SIMULATION OF WATER POLLUTION GENERATION AND ABATEMENT ON SUBURBAN WATERSHEDS,
Washington Univ., Seattle. Coll. of Engineering.
For primary bibliographic entry see Field 5B.
W84-05160

RHINE - PRIORITY FOR DRINKING WATER (AM RHEIN - VORRANG FUR TRINKWASSER),
For primary bibliographic entry see Field 5D.
W84-05272

METHODOLOGY FOR THE CHARACTERIZATION OF WATER QUALITY: ANALYSIS OF TIME-DEPENDENT VARIABILITY,
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
M. Lachance, and B. Bobee.
Journal of Hydrology, Vol. 59, No. 3-4, p 275-291, November, 1982. 3 Fig, 2 Tab, 10 Ref.

Descriptors: *Water quality, *Model studies, *Evaluation, Saint Lawrence River, Aquatic life, Water supply.

The general methodology for characterization of water quality is presented and applied, after elimination of spatial effects, to the analysis of time dependent variability of physicochemical parameters measured on 18 dates during the summer months of 1976 at 12 sampling stations on the Saint Lawrence River between Cornwall and Quebec City. A transferable methodology is presented for characterizing water quality in relation to various uses. The method is based on the use of multivariate statistical methods suitable to the analysis of large data tables. The method is applied to the analysis of time dependent variability of water quality in two cases, namely domestic water supply purposes and ability of the environment to sustain balanced aquatic life. The analyses lead to an overall interpretation of this variability and to a description of the relations between parameters, the relative importance of parameter variations during the period of study, the relations between parameter values intervals and groups of sampling dates, and the behavior of the set of parameters connected to a given use at different dates. The methodology may also be transferred to a river or a given watershed if multiple uses are considered at the same moment. (Baker-IVI)
W84-05342

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

WATER SUPPLY MANAGEMENT ENTERS A NEW ERA,
Raub (Jack G.), Mission Viejo, CA.
D. W. Prasifka.
Civil Engineering, Vol. 54, No. 3, p 45-47, March, 1984. 1 Fig, 3 Ref.

Descriptors: *Water demand, *Water supply development, *Water management, Decision making, Planning, Water supply, Water use, California, Legislation, Risk management.

In a very broad sense, water supply planning has two components - demand fulfillment and hazard mitigation. The first involves providing sufficient water supplies to meet the ultimate water demands of a community. The second involves formulating a course of action to deal with short term and long term interruptions of the available water supply. The political climate in California over the past few years indicates that the era of redundancy planning may be drawing to a close. Rising energy costs and inflationary pressures have increased water rates, both wholesale and retail. The legislature has passed a bill to expand the statewide water importation system as part of one of the most expensive construction programs in the state's history. The impact of changing social attitudes on water management practices is most evident in the response of the Marin Municipal Water District located in the San Francisco Bay area to the 1976-77 drought. MMWD customers reduced their water use more than 60%. Their risk management strategy implies a willingness to live with a system that will periodically require varying levels of conservation to maintain a supply buffer during dry years. Innovative aproaches are the wave of the future. Such approaches must focus on both components of water supply planning - demands and hazards. In projecting ultimate water demands today's engineers must shy away from a blanket reliance on textbook or historical trends in water consumption. An innovative approach would use community characteristics as the most important consideration. The economic consequences of hazard mitigation must also be included in proper planning. Hazard mitigation in any form usually costs something. The threat of severe economic loss in the aftermath of a natural disaster is often used as justification for spending large sums of money on hazard mitigation for water lifelines. The social and economic impacts of natural disasters on the communities living at risk from these hazards should be evaluated. In this respect, hazard mitigation must be inherently political and technological. (Baker-IVI)
W84-04922

RELIABILITY ANALYSIS OF REVERSE OSMOSIS PLANT,
King Abdulaziz Univ., Jeddah (Saudi Arabia).
For primary bibliographic entry see Field 3A.
W84-04938

STRATEGIC PLANNING FOR A NATIONAL WATERWAYS SYSTEM,
Army Engineer Inst. for Water Resources, Fort Belvoir, VA.
A. L. Dietz.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 112, January, 1983. 5 Tab.

Descriptors: *Decision making, *Planning, *National Waterways Study, Risks, Federal jurisdiction, Risk analysis, Transportation, Shipping, Political aspects.

Risk and uncertainty dictated the study design developed for the Congressionally mandated National Waterways Study (NWS). The need for the strategic planning concept adopted for the NWS is explained in terms of the current federal, state and private planning environments. The assumptions used for the scenarios considered by the NWS are tabulated. These include total waterborne commodity flow forecasts, in millions of tons, the selected commodity growth by alternative scenarios from 1977-2003, major growth reaches under high coal export, and waterborne coal flow forecasts by reach, in million of tons. The uncertainties under which planning is carried out are reviewed. The results of analyses of future water transportation use and system capability under a mix of future conditions is summarized, and strategies posed to meet waterway capability needs under uncertain future conditions are described. The NWS results in recommendations to Congress in areas of institutional and policy change necessary to obtain a viable national waterway system that supports national goals. The framework plan, based on the lessons learned from strategies, offers a mix of politically achievable decision rules designed to reduce risk and uncertainty. (Baker-IVI)
W84-04952

MULTIOBJECTIVE APPROACHES TO RIVER BASIN PLANNING,
Control Data Corp., Tucson, AZ.
M. Gershon, and L. Duckstein.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 13-28, January, 1983. 2 Fig, 4 Tab, 29 Ref.

Descriptors: *Water resources development, *Decision making, Planning, Management, Water management, Santa Cruz River Basin, River basins, Game theory, Programming.

The impact of alternative water development strategies upon an urbanized area in the semi-arid Southwest is examined within a multiobjective context. ELECTRE, compromise programming,

cooperative game theory, and multiattribute utility theory were compared by applying each of them to the Santa Cruz River Basin as a case study. The cost effectiveness approach was used to formulate the problem within a multiobjective context, and 25 alternative systems were evaluated and ranked. All of these multi-objective techniques are applicable in river basin planning. The four multi-objective techniques yielded similar results. In the sensitivity analysis, several changes in parameter values were made. In general, all four methodologies are fairly robust with respect to these parameter changes. Since the results obtained by the different methods are similar, work should be done to determine other criteria upon which to base the model choice in future applications. Of the methods used in this study, only ELECTRE can be used to rank systems involving qualitative data with, however, an interval or ratio scale introduced to measure discordance on a cardinal scale. When applying multi-objective decision techniques, both the estimation and use of weights should be examined. It is not practical to attempt to choose one multiobjective decision making technique as the best, nor is it practical to select one as the best for a given problem or a given decision maker or analyst. A thorough understanding of the workings and assumptions of each technique is essential. (Baker-IVI)
W84-04953

ECONOMIC FEASIBILITY OF FLOOD CONTROL IMPROVEMENTS,
Texas A and M Univ., College Station. Dept. of Civil Engineering.
R. A. Wurbs.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 29-47, January, 1983. 14 Ref.

Descriptors: *Flood control, *Economic feasibility, Planning, Water management, Management, Decision making, Cost-benefit analysis, Water policy, Public policy.

There is increasing difficulty in satisfying the economic feasibility criterion in the formulation of structural plans of improvement for flood control. The decreasing benefit-to-cost ratios should be an important consideration in formulating water policy. A reassessment of the role of the economic criterion in determining project justification is warranted. Benefit-cost analysis should play a strong role in project selection. Capabilities need to be developed into the planning and implementation process to allow the economic feasibility constraint to be relaxed whenever noneconomic considerations so dictate. In many respects, incorporation of noneconomic considerations in project justification can be achieved more effectively at the state and local level than at the federal level. The increasing difficulty in economically justifying plans of improvement should also encourage a reassessment of whether the discount rate formula appropriately represents the public interest under changing economic conditions. The economic feasibility issue contributes to the already critical need to develop procedures to expedite the water resources development process. In regard to project planning, the increasing difficulty in economically justifying flood control projects contributes to the need for more innovative plans incorporating a broader range of nonstructural and structural measure types and conditions, expanded evaluation and tradeoff analysis techniques, and improved capabilities for handling the uncertainties involved in an economic analysis. (Baker-IVI)
W84-04954

ENVIRONMENTAL ANALYSIS IN HYDROPOWER LICENSING: A MODEL FOR DECISION MAKING,
American Univ., Washington, DC. School of Government and Public Administration.
For primary bibliographic entry see Field 6G.
W84-05010

MANAGING WITH MICRO-COMPUTERS,
Southern Water Authority, Worthing (England). East Sussex Water and Drainage Div.
R. B. Armstrong.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 1, p 41-54, February, 1983. 8 Fig.

Descriptors: *Computers, *Water management, Management, Decision making, Microcomputers, Administration, Programming.

The effective use of low cost equipment for decision making, monitoring, and control for water management purposes is considered. The information is presented for technical managers who are unfamiliar with computers. Consideration is given to procurement of equipment, programs and packages, and examples of spreadsheet applications. The key words of modern micro-computing are flexibiliy and adaptability. A good general purpose package transforms the micro-computer into an easily usable tool capable of undertaking a wide range of tasks. At the same time the user does not have to invest a large amount of time to make effective use of the machine; neither does the user need to be able to write computer programs. The micro can also be used effectively by the manager's secretary, particularly for word processing. This is invaluable for small businesses or isolated site offices where one machine can serve many masters in different ways. It is flexible and it is able to save a considerable amount of time of both principal and support staff. This is particularly applicable to mundane administrative tasks and leaves more time for creative activity. (Baker-IVI)
W84-05051

PLANNING OF WATER RESOURCES DEVELOPMENT IN AN ARABIAN GULF STATE: QATAR, A CASE STUDY,
J. G. Pike.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 1, p 75-88, February, 1983. 4 Fig, 1 Tab, 12 Ref.

Descriptors: *Water resources development, *Systems analysis, *Qatar, Planning, Water management, Water reuse, Water demand, Groundwater management, Seawater, Desalination, Wastewater irrigation.

There are two fundamental aspects to the question of water development in Arabia: an historic lack of capital to tap underground water reserves; and an absolute scarcity of water in this area where rainfall is insufficient to recharge the aquifers enough to meet the heavy demand now being placed on them. Although the city-states of the Arabian Gulf have not yet developed highly diversified economies, where the injunctive use or optimal apportionment of different souces of water becomes an intricate and complex matter, the rapid pace of development and consequent over-exploitation of meager groundwater resources nevertheless poses a problem in development planning. This is particularly relevant in the situation where natural water resources are likely to be rapidly exhausted and where policies need to be formulated on the extent of future augmentation or substitution of supplies by high cost distilled seawater and the optimum re-use of effluent water. The application of systems analysis in developing a national water resources and agricultural development plan in Qatar has provided an example of how this may be approached. Economically there is no justification for the use of high cost distilled seawater water for agriculture but the systems analysis approach to the problem has shown that, to ensure a long term balanced strategy, and to compensate for over-exploitation of groundwater resources in the past, a modest amount of distilled sea water must be used if the use of treated sewage effluent is to be confined to the irrigation of a limited range of crops in currently uninhabited areas. (Baker-IV)
W84-05052

AQUIFER TESTING, MATHEMATICAL MODELING, AND REGULATORY RISK,
Idaho Univ., Moscow. Coll. of Mines and Earth Resources.
C.-P. Wang, and R. E. Williams.
Ground Water, Vol. 22, No. 3, p 285-296, May-June, 1984. 4 Fig, 5 Tab, 23 Ref.

Descriptors: *Aquifer testing, *Model studies, *Mathematical models, Planning, Water resources development, Water management, Decision making.

The dilemma of a knowledgeable groundwater quality regulator whose regulatory decision making process is confronted with the output of a mathematical model that is based on very limited field test data is described. A method is available to a regulator for assessing approximately a range of possible performances of a contaminated groundwater recovery well field using a range of input data derived from a very limited data base. A strong case is presented for presenting mathematical model outputs as ranges of values rather than as unique solutions. A range is determined by an examination of the level of sophistication of the field data base. Experience gained with 12 field sites is demonstrated. The more limited the field data base, the greater must be the range of defensible model outputs, and consequently, the greater the risk inherent in subsequent regulatory decisions. The regulator can assess the risks in the regulatory decision making process only if he is able to assess the extent to which the field data base for the model output reflects state of the art data collection and analysis technologies and methodologies. (Baker-IVI)
W84-05104

EMERGING CONCEPTS FOR THE CONDUCT OF STATE WATER RESOURCES PLANNING,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
L. Shabman.
Water Resources Bulletin, Vol. 20, No. 2, p 203-209, April, 1984. 23 Ref.

Descriptors: *Water resources development, *Planning, Decision making, Water supply development, State jurisdiction, Water policy.

The capacity of states to conduct water resources planning has increased in recent years in response to changes in federal water resources development programs. The states are pursuing an adaptive planning process focusing on specific policy issues and are attempting to maintain flexibility to adapt decisions to circumstances. Adaptive planning is based upon articulation of basic policy, interest group conflict management and provision of baseline information. Clearly each of the states will develop a planning process that best suits their individual needs. Indeed, the states are still experimenting with how they should approach their planning mission since the emphasis on the importance of state planning is a relatively recent occurrence in the history of U. S. water planning. While this experimentation continues, and while significant differences across states do occur, it is instructive to realize that the basic themes elaborated about the adaptive planning process do seem to be the dominant view of state planning at this time. (Baker-IVI)
W84-05159

OPTIMIZATION METHODS FOR WATER RESOURCES PLANNING PROBLEMS WITH MULTIPLE OBJECTIVES: I. SURVEY OF SOME SUITABLE METHODS (OPTIMIERUNGSVERFAHREN FUR WASSERWIRTSCHAFTLICHE PLANUNGSPROBLEME MIT MEHRFACHER ZIELSETZUNG: I. ZUSAMMENSTELLUNG GEEIGNETER VERFAHREN),
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
W. Gunther, and H. Overland.
Wasserwirtschaft, Vol. 73, No. 7/8, p 221-225, 1983. 2 Fig, 1 Tab, 9 Ref.

Descriptors: *Planning, *Decision making, Water resources development, Multiobjective planning, Optimization.

The determination of the most appropriate project alternative in multiobjective water resources planning is very difficult, because the effects of the different alternatives relevant to each single objec-

tive are often incommensurable. This survey describes some optimization methods helping to solve such problems. Methods described include the following: Goal Programming, Lexicographical Method, Weighting Method, Constraint Method, Noninferior Set Estimation Method, STEM Method, Sequential Multiobjective Problem Solving Technique, Sequential Information Generator for Multiple Objective Problems, Trade-off Development Method, and Surrogate Worth Trade-off Method. (Moore-IVI)
W84-05246

OPTIMAL IRRIGATION PLANNING MODEL (EIN MODELL ZUR PLANUNG UND OPTIMIERUNG VON BEWASSERUNGSANLAGEN),
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
S. Al-Azawi, and G. Marotz.
Wasserwirtschaft, Vol. 73, No. 9, p 279-283, 1983. 2 Fig, 1 Tab, 11 Ref.

Descriptors: *Irrigation programs, *Planning, *Optimization, Decision making, Economic aspects, Crop yield, Soil type, Available water, Fertilizers.

The purposes of this study are: to formulate a model for distributing the available land and water to various competing crops, to decide the type and quantity of each crop that should be planted and to derive the cost benefit function useful for those responsible for planning irrigation projects. However, in this study only one objective will be considered, namely maximization of the net income. The unknown decision variable is the area planted with a feasible crop characterized by its soil type, available water, level of technology, labor, seeds, fertilizer and capital costs. (Author's abstract)
W84-05251

OPTIMIZATION METHODS FOR WATER RESOURCES PLANNING PROBLEMS WITH MULTIPLE OBJECTIVES: II. EXAMPLES OF PRACTICAL COMPUTATION AND PROBLEMS (OPTIMIERUNGSVERFAHREN FUR WASSERWIRTSCHASFTLICHE PLANUNGSPROBLEME MIT MEHRFACHER ZIELSETZUNG: II. ANWENDUNGSBEISPIELE UND AUFTRETENDE PROBLEME),
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
M. Becker, W. Gunther, and H. Overland.
Wasserwirtschaft, Vol. 73, No. 9, p 284-297, 1983. 4 Fig, 4 Tab, 6 Ref.

Descriptors: *Planning, *Water resources development, *Multiobjective planning, Fish, Wildfowl, Amphibians, Aesthetics, Hydroelectic power.

The use of three different multiobjective optimization methods is shown for a practical water resources planning problem including competing objectives, (water power production versus ecological and aesthetic requirements). Ecological objectives include the preservation of fish, amphibians, and waterfowl. The study is based on data taken during a total of 52 weeks from the middle of the years 1950 and 1979. (Moore-IVI)
W84-05252

EXPERIENCES IN MULTIOBJECTIVE PLANNING AND MANAGEMENT OF WATER RESOURCES SYSTEMS,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
U. Shamir.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 77-92, 1983. 8 Fig, 26 Ref.

Descriptors: *Water resources development, *Decision making, Water management, Planning, Multiobjective planning.

Multiobjective decision making is viewed as a philosophy and a process, rather than merely a set of procedures and algorithms. While methodologies are important, the framework within which they are applied and the communication between analysts and decision makers are the crucial determinants of the success of their application. A brief outline is offered of some methodologies which have been found useful in multiobjective planning and managment of water resources systems. Experience gained in several studies is presented. The examples described serve to demonstrate the types of situations were multiobjective decision making in water resources planning and management can be used. The most important features of the methodologies employed are those which create a frameworl. for joint work of the analysts with the decision makers, in a learning process which allows progressive articulation of positions and preferences on the basis of previous analyses. (Baker-IVI)
W84-05299

OPERATING RULE DESIGN FOR RESERVOIR DAMS BUILT IN ORDER TO SUSTAIN LOW FLOWS. 1. THE YEARLY ALTERNATE PROCESS OF INFLOWS AND DEFICITS AS A TOOL (RECHERCHE D'UNE POLITIQUE DE GESTION DES STOCKS D'EAU DE BARRAGES-RESERVOIRS EN VUE DE SOUTENIR LES ETIAGES. 1. ELABORATION D'UN MODELE ALTERNE ANNUEL APPORTS-DEFICITS),
Montpellier-2 Univ. (France). Lab. d'Hydrologie Mathematique.
C. Bocquillon, and J. M. Masson.
Journal of Hydrology, Vol. 60, No. 1-4, p 59-79, January, 1983. 13 Fig, 2 Tab, 6 Ref.

Descriptors: *Water shortage, *Reservoirs, Decision making, Statistical methods, France, Water supply development,.

Lack of water supply during periods of deficient flow affects the economic potential of the great river valleys which are the most developed areas in the country of France. The low flows and variability of water supply call for carry over procedures (reservoir capacity is sometimes greater than the mean available water). As it is not possible to predict future flow sequences, the carry over rule is used as a statistical decision making tool. The flow data are only one of several possible sources of information to be used. However, the analysis of flow data provides statistical measures to generate long series of synthetic inflows associated with summer deficits. A simplification is introduced by choosing only the values which are absolutely necessary for optimal management research: available water volumes and reserve volumes for a flow threshold. Yearly alternate periods of excess and deficiency of water are defined by the values above and below a threshold of flow discharge at a location gage named objective point, where the reservoir effects are to be estimated. Yearly periods are described by water volumes, either inflows into reservoirs, or deficits below various thresholds of summer flow discharges. Marginal and conditional probability distributions of these volumes and the physical laws which mark their bounds and relationships were estimated on the basis of 31 years of daily flow records. The synthetic simulated series of 1000 years was compared to records of historical levels. Extreme events such as sequences of dry years, have return periods of comparable magnitude. This synthetic series has a similar statistical character of short historical series and makes the analysis of operating rules possible. (Baker-IVI)
W84-05349

6B. Evaluation Process

IDENTIFYING ENVIRONMENTALLY ACCEPTABLE LEAST-COST POLLUTION CONTROL SYSTEMS,
Argonne National Lab., IL. Energy and Environmental Systems Div.
M. F. Torpy, A. B. Bishop, and R. Narayanan.
Journal of Environmental Management, Vol. 15, No. 4, p 287-300, December, 1982. 11 Fig, 3 Tab, 11 Ref.

Descriptors: *Model studies, *Economic aspects, *Water pollution control, Waste disposal, Water reuse, Design criteria, Environmental effects, Linear programming, Water resources development.

A mathematical model based on mixed-integer programming was formulated to identify the least-cost treatment and recycle system among alternative pollution control units and environmental and production quality requirements. The model is presented as basis for production managers to evaluate treatment, recycle and discharge options under various conditions, such as changes in water and air quality standards, in plant standards and resource input costs. For a set of conditions, the model identifies the size of the required treatment units in the production treatment system, the flowrates of the influents and effluents, the treatment system's flow pattern, the quality of the water and air effluents, and quantity of residuals disposed of. The non-linear total costs, approximated by sets of linear cost segments, consist of operation and maintenance, water, energy, and capital cost inputs. The results of the applied model identify resource substitution with changes in resource input costs. The use of the model was demonstrated with the design of a 750-megawatt coal-fired steam electric plant. The model is useful to production facility planners in their efforts to minimize costs based on a consideration of changes in resource costs and other objectives. In addition, the method is useful for policy makers who must understand the costs related to changing environmental standards and even define the best available control treatment for the change. The most serious deficiency in the methodology is the inability to optimize with more than one residual parameter per physical phase (solid, liquid or gas). (Baker-IVI)
W84-04819

MEASURING AND PREDICTING WATER QUALITY IN RECREATION RELATED TERMS,
Resources for the Future, Inc., Washington, DC.
W. J. Vaughan, C. S. Russell, L. P. Gianessi, and L. A. Nielsen.
Journal of Environmental Management, Vol. 15, No. 4, p 363-380, December, 1982. 1 Fig, 6 Tab, 24 Ref. EPA grant No. R 806 906 010.

Descriptors: *Water quality, *Predicting, *Recreation, Estimating, Water pollution control, Model studies, Fishing, Policy.

The practical aspects are explored of quantitatively representing three of the five major linkages which are needed in order to estimate the monetary benefits accruing to recreational water users from nationwide implementation of water pollution control policies. These three are: the effects of the program on levels of pollutant discharge by source; the natural systems mechanisms for transportation, dilution, and transformation of pollutants which produce changes in ambient environmental conditions from changes in pollutant discharge levels; and the translation of the ambient changes from scientific measures such as dissolved oxygen into terms readily perceived and acted upon by recreators. A water quality simulation model with both source discharge and natural systems components is employed to predict the ambient effects of increasingly stringent water pollution control policies above a 1972 pre-policy baseline. The ambient effects are cast in recreation-specific terms - in this case, the quantity of fishable water available and its distribution across three broad categories of fish. The model's estimates of these quantities prior to policy implementation are compared to the estimates obtained by the authors from a survey of state fish and game agencies. Model forecasts of the availability of fishable water by species class in the US after the application of increasingly stringent national control policies are provided. This attempt suffers to some extent from several shortcomings: imperfect baseline data, modeling requirements pushing to and beyond the current limits of ability, and imperfect coverage of the totality of US water courses. However, this effort does demonstrate that considerable progress is possible. (Baker-IVI)
W84-04820

INTEGRATED SIZING OF WATER STORAGE AND CONVEYANCE,
Fleming (David E.) Co., Denver, CO.
D. E. Fleming, R. K. Hanson, and J. W. Labadie.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p 94-111, January, 1983. 10 Fig, 3 Tab, 7 Ref.

Descriptors: *Water supply development, *Management, Water storage, Reservoirs, Water conveyance, Conveyance structures, Colorado River Basin, River basins, Model studies, Dynamic programming, Optimum development plans, Optimization.

A methodology employing dynamic programming is presented for integrating the optimal design of water supply, treatment, and conveyance systems where the water demands for various uses vary during the year. Analysis begins with the water conveyance system so as to determine overall monthly water use coefficients for various levels of annual firm releases from the proposed reservoir that maximize net benefits. A firm yield analysis can then be conducted to determine the minimum capacity reservoir needed to supply various levels of firm yield according to the overall monthly water use coefficients computed previously by the dynamic programming algorithm. It is a relatively easy matter to then determine the optimum reservoir size that maximizes total net benefits. This specifies the optimum firm yield from the reservoir, which is in turn used to select the optimum design of each section of the water conveyance system, including pipeline sizings and water allocation to various uses. The results depend on the assumed future price or value of the water to various users. The optimal design of the water conveyance system can change significantly as the available supply changes. A unique feature of the work is that a generalized dynamic programming code called CSUDP was used. Instead of having to develop an entire dynamic programming code from the beginning for each new application CSUDP only required user supplied subroutines for the state transformation equation and objective function as well as input data. (Baker-IVI)
W84-04958

GAUGING THE ECONOMIC VIABILITY OF AGRICULTURAL LAND DRAINAGE SCHEMES,
Middlesex Polytechnic, London (England0. School of Geography and Planning.
E. C. Penning-Rowsell, and J. B. Chatterton.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 2, p 123-142, April, 1984. 4 Fig, 3 Tab, 48 Ref.

Descriptors: *Drainage, *Land development, *Cost-benefit analysis, *Agricultural land, Farming, Rainfall, Permeability, Model studies, Computer models, Economic aspects.

Agricultural land which suffers from poor drainage has only limited use. In practice there is a range of drainage problems. In addition to impeded drainage causing crop damage and reducing grazing potential, the structure of silty soils may suffer progressive deterioration and permanent damage with prolonged saturation. Gauging the economic viability of drainage schemes naturally concerns both costs and benefits, and the former can also be subject to uncertainties and imprecision. Decisions concerning drainage and drainage standards must also balance economic benefits against possible losses in the form of diminished nature conservation value or reduced landscape variety, although these cannot readily be quantified in economic terms. A computer model developed to systematize benefit assessment has four principle operations. Gross margin data appropriate to the benefit assessment in question is assembled from a large computer file of published data by a program called GMDAT. The gross margin data are related to each livestock enterprise and the land use of each field of block of land, which is assembled from farm interview data by program AGASS. The calculations by the program ENHANCEMENT can yield annual enhancement figures for each field and for each livestock type. These figures can be adjusted for each year of the scheme's life, based on anticipated percentage uptake data. Each year's enhancement is discounted to present values and then totalled to estimate the benefits in the form of a capital sum from which the present value of additions to fixed costs can be subtracted. (Baker-IVI)
W84-05137

PERCEIVED WATER QUALITY AND THE VALUE OF SEASONAL HOMES,
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
For primary bibliographic entry see Field 5C.
W84-05153

WATER SUPPLY FORECASTING IN REAL-TIME,
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
A. L. Huber.
Water Resources Bulletin, Vol. 20, No. 2, p 167-171, April, 1984. 1 Fig, 2 Tab, 5 Ref.

Descriptors: *Water supply, *Forecasting, Statistical models, Snowmelt, Snow water equivalent.

A strategy is developed for making seasonal water supply forecasts in real time. It links the traditional regression based forecasting techniques to real time data acquired by systems such as the Soil Conservation Service SNOTEL and the Bureau of Reclamation Hydromet networks. The concept is based on interpolating between the forecast values obtained by using real-time data in the forecast equations that bracket the real time. Different interpolation procedures were examined and the procedure for calculating confidence intervals about the forecast estimates is developed. The entire conceptual procedure is demonstrated using data from the Reynolds Creek, Idaho, experimental watershed. Advantages of the method include conceptual simplicity and established credibility, computational efficiency with minimum computer requirements, rapid implementation, and a bridge between historical and new real time data. (Baker-IVI)
W84-05154

INTERNATIONAL COOPERATION IN HYDROLOGY AND WATER RESOURCES DEVELOPMENT,
Rijkswaterstaat, The Hague (Netherlands).
A. Volker.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 49-56, 1983. 2 Fig.

Descriptors: *Hydrology, *Water resources development, International agreements, Decision making, Hydraulic design, Water management.

The history, nature and extent of the relationship between hydrology and the basic sciences and the international cooperation in that field are discussed. Hydraulic structures have been designed based upon experience obtained in a particular area and with a particular river and when such experience was missing a failure was bound to occur. The earliest dams were built without hydrological information and without knowledge of fundamental hydraulics and some still performed their function for many decades or even centuries with some of them still standing. Systematic international cooperation in the field of hydrology started in 1922 when a section for hydrology was established within the International Union of Geodesy and Geophysics. At the Moscow General Assembly of 1971 two important changes were made. The first was a change of the name of the association with scientific hydrology being replaced by hydrological sciences. The second change involved the establishment of a new Commission within the association, the Commission on Water Resouces Systems. Current matters of concern include the association of water management to the environmental impact of hydraulic works, the practical application of hydrology and water management under conditions prevailing in developing countries, the status of hydrology in developing countries, the prediction of hydrological side effects and their so-called environmental effects, and the application of history lessons to hydrology and water management. (Baker-IVI)
W84-05297

ECONOMIC ACTIVITY, WATER RESOURCES AND THE ENVIRONMENT; A CHALLENGE FOR HYDROLOGY,
United Nations Environment Programme, Nairobi (Kenya).
G. N. Golubev.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 57-75, 1983. 6 Fig, 4 Tab, 28 Ref.

Descriptors: *Water resources development, *Economic aspects, Hydrology, Environmental effects, Reviews.

Great pressure is exerted on hydrological, erosion/sedimentation and biogeochemical cycles by rapid economic development and population growth. The cycles are closely related with the hydrological cycle having the leading role. The roles of water withdrawals, reservoirs and transfers are discussed as compared with the natural components of the water balance. The impacts of irrigation and agriculture are considered in general. Closed lakes and their problems, and water management concerns stemming from the current water resources situation are investigated. The impacts of human activity on water and erosion/sedimentation are considered with particular emphasis on the consequences of agriculture. Impacts of economic activity on water and hydrochemistry are considered along with changes of chemical transport by rivers, and perturbations of the nitrogen and phosphorus cycles. The need for an active control of water resources and hydrologic regime on a large scale is considered. The control inevitably requires an interdisciplinary approach based on understanding the wide scope of hydrological processes. For hydrology there is no other way but to accommodate itself to this interdisciplinary setting. (Baker-IVI)
W84-05298

ASSESSING THE ENVIRONMENTAL BEHAVIOUR OF AQUATIC POLLUTANTS,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
W. Stumm.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 93-102, 1983. 3 Fig, 2 Tab, 3 Ref.

Descriptors: *Water quality control, *Pollutants, Decision making, Water management, Geochemical cycle, Xenobiotic substances, Environmental effects, Residence time, Biomagnification, Adsorption.

In view of the great number of existing chemicals and considering the large amount of environmental pollutants created every day by civilization there is a need to develop and apply general concepts (physical chemical substance specific data, unit processes) on the behavior, distribution and fate of pollutants in order to assess their environmental behavior and their potential effects on ecological systems and on human health. The geochemical cycle and its relationship to water quality are reviewed. The two most commonly used water quality criteria (the concentration of dissolved oxygen and the use of indicator organisms) are no longer sufficient as the character of pollution has changed over the last decades, especially in industrialized and densely populated regions. In interpreting the presence of indicator organisms, one is frequently at a loss to explain the cause and effect relationship of their presence. The response of aquatic ecosystems to xenobiotic substances, environmental analytical chemistry, and the chemical dynamics of pollutants are considered. (Baker-IVI)
W84-05300

OPTIMIZATION OF GROUNDWATER ABSTRACTION FROM A COASTAL AQUIFER,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 4B.
W84-05304

QUANTITATIVE APPROACH TO DETERMINING LAND USE DENSITIES FROM WATER SUPPLY AND QUALITY,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
P. J. Pizor, G. H. Nieswand, and R. M. Hordon.
Journal of Environmental Management, Vol. 18, No. 1, p 49-56, January, 1984. 1 Fig, 4 Tab, 9 Ref.

Descriptors: *Community development, *Land use, *Water supply development, Planning, Urban development, Water supply, Water demand.

As pressures mount on existing water supplies, a consideration of available water is becomming of increasing concern to those planners responsible for setting lot size recommendations. Until recently no specific linkage had been made between the volume and quality of water and the consequent lot size. Current planning capacity is a measure of the ability of a region to accommodate growth and development within limits defined by existing infrastructure and natural resource capabilities. A model is developed for determining CPC for areas serviced by infrastructure, or by on-site septic systems and wells. Infrastructure capacity is a function of water supply and sewerage treatment plant capacity, existing pipe sizes, and current demand. CPC calculations for on-site water supply potential are a function of the productivity of the underying aquifer. On-site water quality impact is estimated by the dilution capability of groundwater. The application of the CPC model for water supply and water quality parameters and subsequent lot size recommendations for a growing municipality are presented. A quantitative approach is offered for areas served by on-site wells and septic systems, for areas served by on-site wells, and for non-sewered areas. (Baker-IVI)
W84-05305

ECONOMIC RESULTS OF SIMULATED CHANGES IN PAKISTAN'S IRRIGATION SYSTEM,
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 3F.
W84-05335

OPERATING RULE DESIGN FOR RESERVOIR DAMS BUILT IN ORDER TO SUSTAIN LOW FLOWS. 1. THE YEARLY ALTERNATE PROCESS OF INFLOWS AND DEFICITS AS A TOOL (RECHERCHE D'UNE POLITIQUE DE GESTION DES STOCKS D'EAU DE BARRAGES-RESERVOIRS EN VUE DE SOUTENIR LES ETIAGES. 1. ELABORATION D'UN MODELE ALTERNE ANNUEL APPORTS-DEFICITS),
Montpellier-2 Univ. (France). Lab. d'Hydrologie Mathematique.
For primary bibliographic entry see Field 6A.
W84-05349

OPERATING RULE DESIGN FOR RESERVOIR DAMS BUILT IN ORDER TO SUSTAIN LOW FLOWS. 2. OPERATING RULE FORMULATION (RECHERCHE D'UNE POLITIQUE DE GESTION DES STOCKS D'EAU DE BARRAGES-RESERVOIRS EN VUE DE SOUTENIR LES ETIAGES. 2. UTILISATION D'UN MODELE ALTERNE ANNUEL APPORTS-DEFICITS POUR LA RECHERCHE DES CONDITIONS DE GESTION),
Montpellier-2 Univ. (France). Lab. d'Hydrologie Mathematique.
C. Bocquilon, and J. M. Masson.
Journal of Hydrology, Vol. 60, No. 1-4, p 81-104, January, 1983. 10 Fig, 1 Tab, 3 Ref.

Descriptors: *Reservoirs, *Design criteria, Decision making, Flow, Water supply development, Water management, River Loire, France.

The construction of five reservoirs was planned for the upper catchment of the River Loire, France, to sustain the low flows in the Loire valley. Daily draft decisions must be made at every stage of the project. A hydrological criteria concerning the low flows at a station in the valley is used to judge the results. It is possible to determine the optimal reservoirs and annual deficits, when the future conditions are presumed to be known. The statistical analysis of the results aids in the formulation of the objectives for the long term assuring the carry over storage for a predetermined risk of failure. This long term objective will not hold good if the low flow is severe. Thus some deterministic and statistical hypotheses have been used to formulate an objective for the mean term of flow which is calculated each day and adjusted to the hydrological conditions of the year. Water is discharged each day to meet this target flow, while maintaining all the constraints of the flows downstream to the reservoirs. It takes into account the time needed for transfer of water and permits a good prediction of either the flow propagation in the upper watershed or the evolution of the inflows from downstream catchments. A modular model is used to calculate the daily flow. The results obtained from simulation were satisfactory. (Baker-IVI)
W84-05350

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ESTIMATING THE VALUE OF WATER AMONG REGIONAL ECONOMIC SECTORS USING THE 1972 NATIONAL INTERINDUSTRY FORMAT,
Max C. Fleischmann Coll. of Agriculture, Reno, NV. Div. of Agricultural Economics.
T. R. Harris, and M. L. Rea.
Water Resources Bulletin, Vol. 20, No. 2, p 193-201, April, 1984. 2 Tab, 33 Ref.

Descriptors: *Water allocation, *Value, *Economic growth, Economic development, Linear programming, Model studies, Estimation, Social aspects.

With economic expansion, esecially in the western U.S., the adequacy of future water supplies to sustain economic growth is questioned. Not only will economic expansion increase demands upon current water resources but the question of western rivers maintaining adequate instream flow compounds this problem. An interindustry-linear programming model based on the 1972 national model format was developed which could be used for water resources planning. The interindustry-linear programming model allocates water among competing economic sectors, which maximizes regional value added while meeting the constraints of the regional economy. Since current water allocations are done by property right or other institutional arrangements and not by a market mechanism, the potential for misallocation of water exists. Using the interindustry-linear programming model, marginal value of water for different users is derived and allocation of water resources which maximizes social welfare is determined. (Moore-IVI)
W84-05158

VESSEL LICENSING FEE AS AN ALTERNATIVE PROPOSAL FOR A DEEP DRAFT WATERWAY USER CHARGE,
Oregon State Univ., Corvallis. Dept. of Agricultural and Resource Economics.
M. V. Martin.
Water Resources Bulletin, Vol. 20, No. 2, p 219-221, April, 1984. 1 Tab.

Descriptors: *User charges, *Waterways, Water cost, Ports, Licenses, Shipping, Benefits, Costs, Maintenance, Operation.

Congress is considering the imposition of a user fee on deep draft waterways and ports. Two major bills emerged in the 98th Congress. One proposes a tax on import-export value while the other proposes a tax on import-export tonnage. Another user fee alternative is suggested, a vessel licensing system. The advantages of such a fee system are outlined under a set of assumed objectives and the range of possible license charge levels is discussed under a cost recovery target of $250 million. This proposal for financing some portion of Federal deep draft waterway improvement, operation and maintenance expense, rests on the notion that U.S. ports and trade would be only minimally affected by a fixed cost increase for ocean vessels. A license fee would be relatively easy to collect. Moreover, enforcing compliance would require little new bureaucracy. (Baker-IVI)
W84-05161

ANALYSIS OF RISING IRRIGATION COSTS IN THE GREAT PLAINS,
G. R. Sloggett, and H. P. Mapp.
Water Resources Bulletin, Vol. 20, No. 2, p 229-233, April, 1984. 1 Fig, 4 Tab, 8 Ref.

Descriptors: *Water costs, *Great Plains, *Irrigation water, Groundwater recession, Energy costs, Inflation, Groundwater irrigation.

Irrigation costs are rising rapidly on the 32 million acres irrigated with ground water. Ground water levels are declining under about 15 million of those acres adding to increased costs. However, from 1975 to 1982, 75 to 80% of increased ground water irrigation costs were due to higher nominal energy prices and interest rates. In real dollars, adjusted for inflation, these costs have risen faster than other irrigation costs and the real rise in commodity prices has been very small. A continuation of rapidly rising costs and slowly rising prices will shorten the economic life of those aquifers experiencing declining water levels. That same condition of prices and costs place all ground water irrigators in a disadvantaged position compared to non-irrigators and could cause a decline in ground water irrigation. (Author's abstract)
W84-05163

CAPITAL COSTS OF RURAL WATER SYSTEMS: AN EMPIRICAL APPROACH,
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
G. Ramamurthy, and D. L. Chicoine.
Water Resources Bulletin, Vol. 20, No. 2, p 255-260, April, 1984. 3 Tab, 13 Ref.

Descriptors: *Rural areas, *Water distribution, *Water treatment facilities, *Capital costs, Cost analysis, Construction costs, Econometrics, Water conveyance, Storage tanks, Pipelines.

Because of design and material differences, capital cost estimates from urban systems are not uniformly applicable to rural water services. This study presents an econometric analysis of capital costs, using Illinois rural water system construction contract bids. Capital costs are defined as any expenditure involved in completing construction of systems including material, labor, interest and professional services. Items included are ground and elevated steel storage tanks, the major conponents of the pipeline system, the distribution network and the treatment plant. Cost data analyzed account for 90% of the capital costs of water treatment and distribution systems providing farm and nonfarm users in the countryside domestic water service in Illinois. The information presented on capital costs is not intended to replace the detailed cost estimates required for bidding contracts or for costing out a specific rural water system. The type of information can be useful in initial feasibility analysis, general planning programs and the like. (Moore-IVI)
W84-05167

MODEL FOR CONSTRAINED OPTIMUM WATER PRICING AND CAPACITY EXPANSION,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
G. C. Dandy, E. A. McBean, and B. G. Hutchinson.
Water Resources Research, Vol. 20, No. 5, p 511-520, May 1984. 5 Fig, 4 Tab, 22 Ref.

Descriptors: *Pricing, Economic aspects, Model studies, Water management, Water supply, Optimum development plans.

A general model is presented for identifying the water price horizon so as to maximize the present value of net benefits. Previous studies of optimum water pricing and capacity expansion have ignored the political and administrative factors which limit the range of feasible decisions. Constraints on the range of water price, the rate of price change, and financial cost recovery are included in this model. The model is solved using discrete dynamic programming. The general model was applied to a hypothetical case study of an urban water supply system in order to evaluate the effectiveness of constrained and unconstrained optimum water pricing and capacity expansion. When compared to the current practice of average cost pricing, optimum pricing and capacity expansion are likely to result in some increases in net economic benefits, although the percentage increase in unlikely to be large. The imposition of administrative constraints on price changes and cost recovery tend to produce more realistic pricing policies but with some loss in net economic benefits resulting in only a slight improvement over average cost pricing. (Baker-IVI)
W84-05325

ECONOMICAL WAYS OF DEALING WITH WATER SUPPLIES IN THE USSR (ZUM WIRTSCHAFTLICHEN UMGANG MIT WASSERVORRATEN IN DER UDSSR),
Ministerstvo Melioratsii i Vodnogo Khozyaystva SSSR, Moscow.
I. Borodawtschenko, and I. Losanowskaja.
Wasserwirtschaft-Wassertechnik, Vol. 33, No. 5, p 172, May, 1983.

Descriptors: *Water supply, *Water supply development, Water conservation, Water use, Water use efficiency, Irrigation systems.

A 25% reduction in polluted wastewater entering surface waters and a 2% decrease in water-transport-related losses have been achieved in the USSR. During the last 10 yr, water-conservation measures have been instituted in 135 towns and in 1,045 companies in the most important river and sea basins. The Water Surveillance Agencies of the Ministry for Land Improvement and Water Management play an important role in rational and economic water use, not least in granting permits for special water use, which is only done when the applicant is willing to raise the level of multiple water use, institute water-conserving technological processes, and achieve a higher standard of wastewater treatment. The Water Management Ministry is currently working on a series of documents setting standards in this area. Businesses are now required to submit drafts of their annual and five-year plans for nature conservation to the local soviet before sending them to the authorities. In addition, 50% of water that must be paid for is now part of the local budget. The role of the soviet has thereby been increased. Significant water savings can be realized through the implementation of progressive water-use norms in agricultural irrigation; such norms are yet to be developed. The agricultural community can help reduce freshwater demand by using more irrigation-runoff water, wastewater from agricultural production, and municipal wastewater for irrigation purposes. Wastewater utilization also ensures a stable animal-feed supply and prevents pollution of water resources. Plans for 1983 include first-time irrigation of 677,000 ha and drainage of 715,000 ha. Renovation of equipment on 940,000 ha will also occur. (Gish-IVI)
W85-04801

6D. Water Demand

PROJECTIONS OF OUTDOOR RECREATION PARTICIPATION FOR WYOMING: 1995,
Wyoming Water Research Center, Laramie.
J. Carlson, and C. Phillips.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84 171115, Price codes: A08 in paper copy, A01 in microfiche. Completion Report, May, 1980. 161 p, 15 Tab, 2 Append. Project No. OWRT A-025-WYO(1), Contract/Grant No. 14-34-0001-9054.

Descriptors: *Recreation, Water allocation, Water management, Planning, Boating, Fishing, Swimming, Camping, *Wyoming, *Recreation demand, *Recreation facilities, *Surveys, Projections.

Through use of Survey questionnaires, projected estimates are provided for: 1) current activities by Wyoming residents and project participation to the year 1995; and 2) The use of Wyoming's major streams and standing waters for selected water-based recreation activities. A cross-section survey of Wyoming households was used to collect the basic recreation data needed of: who participates, how often, and where. The population from which the main sample was drawn consisted of all households listed in Wyoming telephone directories. Three special population groups were surveyed to obtain information on their recreation participation: handicapped people, Indians, and new residents of the state. A second questionnaire was used to collect information from participants regarding the area where they participated for use in allocating the statewide estimates and projections to the seven planning regions in the state.
W84-04885

SHARE OF HYDRO-ELECTRIC POWER IN THE WORLD ENERGY BALANCE (PLACE DE L'HYDROELECTRICITE DANS LE BILAN ENERGETIQUE MONDIAL),
Electricite de France, Paris. Direction de l'Equipement.
J. Cotillon.
La Houille Blanche, Vol. 5/6, p 381-392, 1982. 3 Fig, 10 Tab, 12 Ref.

Descriptors: *Hydroelectric power, *Electric power production, Resources development, Pumped storage, Peaking capacity, Water resources development, Powerplants, Hydroelectric plants.

Total developable hydropower is estimated at 10,000 - 12,000 TWh, representing 27% to 33% of the total theoretical potential. Hydropower is more evenly distributed throughout the world than coal, oil, gas, or uranium reserves, although within large regions there may be considerable imbalance, with most of the potential being concentrated at a few sites. In 1978, developed potential represented only 17% of the developable potential (98,000 TWh) and 21.7% of total electricity production. Two-thirds of the developed potential was confined to the 24 OECD countries, which have harnessed 50% of their potential on the average; France had reached 90% by the end of 1981. By the year 2000, 35% might be developed, with the OECD countries accounting for 15%, the USSR, India, Mexico, Brazil and Yugoslavia accounting for 12%, and the rest of the world, 8%. Pumped storage is expanding rapidly in Japan, USA, and western Europe. It is just as attractive to engineers and the construction industry as conventional hydro, but it does not produce energy; it merely stores it for future use. Conventional hydro schemes are also growing in size, being increasingly sited on large rivers in the plains. Where alternative capacity exists on the grid, hydropower is being used for peaking duty. The share of hydropower in total electricity will have dropped from 40% in 1925 to 13% by the year 2000. Its share in total energy, which rose form 1.7% in 1925 to 5.3% in 1974, is expected to reach 6-7% by the end of the century. (Moore-IVI)
W84-05017

CONSUMPTIVE WATER USE OF IRRIGATED PECANS,
Texas A and M Research and Extension Center, El Paso.
For primary bibliographic entry see Field 3F.
W84-05071

ESTIMATING THE VALUE OF WATER AMONG REGIONAL ECONOMIC SECTORS USING THE 1972 NATIONAL INTERINDUSTRY FORMAT,
Max C. Fleischmann Coll. of Agriculture, Reno, NV. Div. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W84-05158

PRIVATE AND INDUSTRIAL WATER DEMAND IN WEST GERMANY (DER PRIVATE UND INDUSTRIELLE WASSERBEDARF IN DER BUNDESREPUBLIK DEUTSCHLAND),
Umweltbundesamt, Berlin (Germany, F.R.).
H. Langer.
Wasserwirtschaft, Vol. 73, No. 7/8, p 210-215, July-August, 1983. 6 Fig, 6 Ref.

Descriptors: *Water demand, *West Germany, *Domestic water, Industrial water, Computer models, Prediction, Energy, Water use, Consumptive use.

The present water demand of specific consumer sectors (domestic, industry, and energy production) in the Federal Republic of Germany are compared with possible alternative developments in these sectors up to the year 2010. The predictions are based on a computer-aided forecasting model. The model is designed to predict water use, water withdrawal and water consumption. The largest increase in water-withdrawal would be in energy production (68%). The model predicts an increase of 23% for industry and 9% for the domestic sector. Water use would increase 37% for energy production, 7% for industry, and 16% for the domestic sector. Water consumption would increase 58% for energy production, 39% for industry, and 3% for the domestic sector. (Moore-IVI)
W84-05244

QUANTITATIVE APPROACH TO DETERMINING LAND USE DENSITIES FROM WATER SUPPLY AND QUALITY,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 6B.
W84-05305

6E. Water Law and Institutions

INCENTIVES AND DISINCENTIVES FOR WATER CONSERVATION IN THE CALIFORNIA STATE WATER POLICYMAKING PROCESS,
California Univ., Los Angeles. Dept. of Political Science.
For primary bibliographic entry see Field 3D.
W84-04882

CHANGING ALLIANCES IN CALIFORNIA WATER ISSUES,
California Univ., Davis. Dept. of Applied Behavioral Sciences.
D. Gwynn, and O. E. Thompson.
California Agriculture, Vol. 38, No. 3-4, p 20-22, March-April, 1984. 2 Tab. Univ. of CA Agricultural Experiment Station grant 3559.

Descriptors: *Legislation, *Water resources development, *Political aspects, *California, Water conservation, Agriculture, Water use, Decision making, Peripheral Canal Referendum, Water Resources Initiative Statute.

The Peripheral Canal referendum, which would have allowed major water development projects to proceed, and the Water Resources Initiative Statute, which would have introduced many restricions on water use, including groundwater management, were placed before the voters in California in 1982. Both proposals were soundly defeated. The latter of the two would have added new sections to the State Water Code. It would have revised laws by requiring a water conservation program to be in place in overdrafted natural watershed basins before new or increased basin transfers of more than 20,000 acre-feet per year could be approved. These recent political battles suggest that no single monolithic group controls the development of water policy in the state. While some powerful interests such as oil and utilities remained united on the same side in each election, others became substantially less or more involved depending on what was at stake for them. The coalition most likely to win in a political conflict over water will likely be the one that is

able and willing to spend to most money on the campaign, regardless of the number of donors involved. (Baker-IVI)
W84-04887

DISTRICT MANAGEMENT FOR CALIFORNIA'S GROUNDWATER,
California Univ., Berkeley. School of Law.
D. A. de Lambert.
Ecology Law Quarterly, Vol. 11, No. 3, p 373-400, 1984. 183 Ref.

Descriptors: *Groundwater management, *Legislation, *California, Legal aspects, Water management, Water resources development, Water demand, Water use, Water allocation.

California's current groundwater management law is woefully inadequate. Increased pumping of overdrafted basins, with its concomitant side effects, is an unsatisfactory means of allocating a scarce and valuable resource. Only a comprehensive statewide management program can effectively protect groundwater resources. Pumpers currently depend on the courts to provide basin by basin solutions. Unfortunately, courts are not well equipped to allocate groundwater. Court resources are already overtaxed, and continuing jurisdiction merely adds to their burdens. Furthermore, overdraft requires immediate solutions to prevent environmental and economic havoc, while groundwater adjudications typically drag on for years. Groundwater allocations ultimately require policy decisions better resolved by the legislature than the courts. Politics is the process of deciding who gets how much, when, and why. Without a doubt, the allocation of groundwater fits within this definition. Where too many are demanding too much of a scarce resource, political choices must be made. (Baker-IVI)
W84-05045

LEGISLATING COST-BENEFIT ANALYSIS: THE FEDERAL WATER POLLUTION CONTROL ACT EXPERIENCE,
Jenner and Block, Chicago, IL.
J. K. Baum.
Columbia Journal of Environmental Law, Vol. 9, No. 1, p 75-111, 1983. 116 Ref.

Descriptors: *Water pollution control, *Legislation, *Cost-benefit analysis, Decision making, Water management, Federal jurisdiction, Political aspects.

Increased use of cost-benefit analysis is a key element of current efforts to reform the federal regulatory process, particularly in the field of environmental regulation. The cost benefit analysis requirements for effluent limitations and new source performance standards under the Federal Water Pollution Control Act (FWPCA) amendments of 1972 and 1977 offer particularly useful guidance. Despite gradations of analysis, the cost tests under the various FWPCA provisions have blurred, and this deviation from the statutory language has been largely countenanced by the reviewing courts. This blurring has resulted in ad hoc evaluations by EPA administrators, who treat all steps of the regulatory schedule the same, thus thwarting the goals of predictability and intellectual coherence in the law. The legislative history of best available technology, best available demonstrated control technology and best conventional pollutant control technology is reviewed. Both the executive branch and the judicial branch are cited for the failure of the FWPCA's cost consideration scheme. The EPA has twisted ambiguous statutory language and defined unambiguous language in the service not of environmental protection but of institutional discretion. The fundamental failure however, has been a legislative one. The FWPCA demonstrates the heavy price the public pays when legislators resolve the differences among themselves by enacting deliberately ambiguous legislation. While cost benefit analysis is unquestionably a useful tool in decision making, it is no substitute for the clear expression of congressional values, preferably on the face of the statute. (Baker-IVI)
W84-05047

COPING WITH UNCERTAINTY IN ENVIRONMENTAL DECISIONS,
Thermo Electron Engineering Corp., Waltham, MA.
A. M. Duda, M. T. El-Ashry, and A. Bruch.
Journal of Soil and Water Conservation, Vol. 39, No. 2, p 95-98, March-April, 1984. 2 Fig, 8 Ref.

Descriptors: *Planning, *Water conservation, Decision making, Environmental effects, Legislation, Policy making, Public rights, Drinking water, Acid rain.

The three key commonsense principles followed in TVA's decision on the soil erosion and stream blockage problem were also important factors in developing their position on acid precipitation. Despite uncertainties associated with acid precipitation, especially cause-and-effect relationships, facts were considered. A wealth of circumstantial evidence was revealed about the risks to sensitive ecosystems posed by acid precipitation. In order to minimize these risks, TVA decided to adopt the position that emissions should not be increased and, in fact, should be decreased until more information was available. A feedback system is established for fine tuning the program as more information is made known. An initial modest emissions cap could have served as the first step in an approach to controlling acid precipitation precursors in 1982. Decision makers cannot afford to wait until definitive answers to all uncertainties are reached. (Baker-IVI)
W84-05054

REGULATION OF TOXIC POLLUTANTS UNDER THE CLEAN WATER ACT: EPA'S TEN YEAR RULEMAKING NEARS COMPLETION,
Wyche, Burgess, Freeman and Parham, Greenville, SC.
B. W. Wyche.
Natural Resources Lawyer, Vol. 15, No. 3, p 511-536, 1983. 4 Tab, 128 Ref.

Descriptors: *Water pollution control, *Legislation, *Clean Water Act Legislation, Water quality, Hazardous materials, Regulations, Pollutants, Political aspects.

EPA's ten year struggle to establish regulatory controls on toxic pollutants under the federal Clean Water Act is reviewed. The history of the litigation is cited, the federal district court's three substantive opinions issued in the case during 1982 are analyzed, and the possibility of legislative intervention is considered. Although enacted in 1948, the Clean Water Act did not become an effective piece of environmental legislation until 1972. Even then Congress hoped for a swiftly established and effective toxic pollutant control program. This hope proved illusory as large gaps appeared in scientific information on toxic pollutants and the EPA failed to meet the ninety-day deadline for publishing its list of toxic pollutants. At the time the 1972 Amendments were enacted, Congress created the National Commission on Water Quality to assess the effectiveness of the new statutory scheme in improving water quality and to suggest any changes in the act that might be necessary. This resulted in the Clean Water Act of 1977. A tabular summary of the status of EPA's toxic pollutant control regulations as of April 1, 1983 is offered. The impact of EPA's delay in establishing limitations on each pollutant of concern in a particular discharger's waste stream and possibility of legislative response is considered. A deadline suit has been started which involves issuance of the hazardous wastes landfill regulations. The basic problem is that the deadline suit interjects a court in the middle of what is essentially a political dispute between the legislative and executive branches of government. Moreover, any order issued in such a case is unenforceable as a court cannot write the regulations in question or appropriate additional funds for the agency to do so. (Baker-IVI)
W84-05077

GEOGRAPHICAL ANALYSIS OF VOTING PATTERNS FOR WATER RELATED CONSTITUTIONAL AMENDMENTS IN TEXAS, 1957-1981,
North Texas State Univ., Denton. Dept. of Geography.
F. A. Schoolmaster, III.
Water Resources Bulletin, Vol. 20, No. 2, p 151-162, April, 1984. 9 Fig, 1 Tab, 44 Ref.

Descriptors: *Legislation, *Texas, *Water resources development, *Water quality, Voting, Reservoirs, Funding, Water management, Public opinion, Public participation, Attitudes.

County level electoral data were used to analyze the voting patterns of eight water related constitutional amendment elections. Both water quality enhancement amendments (1971, 1976), and three of six water development amendments (1957, 1962, 1966) have been ratified, thus establishing a statewide policy of reservoir development, a funding mechanism to implement such a policy, and the creation of a water management agency. Beginning with the 1969 election, a West Texas-East Texas regionalized voting pattern has emerged, resulting in the defeat of three amendments (1969, 1976, 1981) intended to provide additional funding for water development. This regionalization reflects different climatic, physiographic, economic, and locational factors, and represents a potential obstacle to coordinated water management in Texas. (Author's abstract)
W84-05152

PUBLIC WATER SUPPLY AS SPHERE OF ECONOMIC ACTIVITY OF THE LOCAL AUTHORITIES (DIE OFFENTLICHE WASSERVERSORGUNG ALS WIRTSCHAFTLICHES BETATIGUNGSFELD DER GEMEINDEN),
Zweckverband Landeswasserversorgung, Stuttgart (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W84-05245

UTILIZATION OF THE RESULTS OF WASTEWATER TAX CONTROL TESTING FOR OTHER PURPOSES (VERWENDUNG VON ERGEBNISSEN DER ABWASSERABGABENUBERPRUFUNGEN ZU ANDEREN ZWECKEN),
For primary bibliographic entry see Field 6F.
W84-05270

HARDSHIP REGULATIONS OUTSIDE SECTION 9, PARAGRAPH 6 OF THE WASTEWATER TAX LAW (HARTEREGELUNGEN AUSSERHALB DES SEKTION 9 ABS. 6 ABWAG),
For primary bibliographic entry see Field 5D.
W84-05273

6F. Nonstructural Alternatives

OPTIMAL OPERATION OF MULTIPLE RESERVOIR SYSTEMS,
Texas Dept. of Water Resources, Austin. Engineering and Environmental Systems Section.
For primary bibliographic entry see Field 4A.
W84-04956

CURRENT WATER ISSUES,
Resources for the Future, Inc., Washington, DC. Renewable Resources Div.
K. D. Frederick.
Journal of Soil and Water Conservation, Vol. 39, No. 2, p 86-91, March-April, 1984. 2 Fig, 11 Ref.

Descriptors: *Water resources development, *Management, Planning, Water demand, Legislation, Regulations, Federal jurisdiction, Public rights, Legal aspects, Doctrine of Prior Appropriation, Saline water intrusion.

Water needs tend to be location- and time-specific and these needs often do not coincide with the availability of natural supplies. Quality of the supply is becoming an increasingly important consideration in assessing the adequacy of supplies for meeting future water needs. Threats to groundwater quality continue to grow and they will become

much more difficult to reverse. Efforts to locate potential sources of contamination by the end of 1982 turned up more than 80,000 pits, ponds and lagoons storing industrial, municipal, agricultural or mining wastes. In addition more than 16 million septic tanks regularly disperse effluent into the ground. Most of these sites are unmonitored. Saline water intrusion also poses a problem in coastal areas where groundwater pumping may allow the seawater to enter freshwater aquifers. State law and water institutions provide guidelines for sharing and using water. Recognition of the need for better groundwater management has led all western states except Texas to abandon the doctrine of absolute groundwater ownership. Most now follow the doctrine of prior appropriation. The basic principle is to grant groundwater permits when the use is beneficial and does not unduly affect prior users. The federal government plays an important role in determining how and where water is used through water projects, reservation of water rights for federal and Indian lands and for navigation, environmental regulations, and negotiation and enforcement of international or interstate compacts. Failure to develop institutions and policies capable of allocating scarce water resources efficiently among competing uses and failure to protect supplies from abuse underlie the nation's water problems. (Baker-IVI)
W84-05053

UTILIZATION OF THE RESULTS OF WASTEWATER TAX CONTROL TESTING FOR OTHER PURPOSES (VERWENDUNG VON ERGEBNISSEN DER ABWASSERABGABENUBERPRUFUNGEN ZU ANDEREN ZWECKEN),
H. Keune.
Wasser, Luft und Betrieb, Vol. 27, No. 3, p 20-21, March 1983. 17 Ref.

Descriptors: *Water law, *Water quality standards, *Wastewater composition, *Wastewater pollution, *Wastewater management, *Wastewater tax control, *Wastewater analysis, Water quality control, Administration, Administrative decisions, Administrative regulations.

In the Federal Republic of Germany, the consequences of a company violating standards for wastewater discharge can be numerous. The results of testing wastewater discharge serve to maintain the standards according to the wastewater tax law. The Water Conservation Law (WCL) states that a water user who has employed a water-conservation expert found not to be discharging his duties satisfactorily can be required to find a new water-conservation expert. Only the water user has the right to appeal this ruling to the water authority. The water authority may impose a fine in addition to or instead of such administrative procedures. In any case, the authority is obliged to hear the appeal of the user. According to the state law of Nordrhein-Westfalen, a fine may be imposed for a variety of reasons. If conditions mean that the wastewater discharger has to violate standards, he must notify the authority before he begins to do so in order to avoid penalty. Other West German states have not copied this law. If the violation of regulations is severe enough to warrant criminal proceedings, the state attorney's office (SOA) is responsible, for investigating the case and is obligated also to look for exonerating circumstances. SAO investigations should also include the circumstances that will determine the sentence. The SAO may demand information about a company from any public authority. (Gish-IVI)
W84-05270

MULTIPLE PAYMENT FOR PREEXISTING POLLUTION (MEHRFACH-BEZAHLUNG DER VORBELASTUNG),
G. Schulz.
Wasser, Luft und Betrieb, Vol. 27, No. 4, p 26, April 1983. 2 Ref.

Descriptors: *Payment, *Multiple payment, *Preexisting pollution, *Water pollution sources, *Water quality management, *Pollution taxes, Economic aspect, Tax rates, Mathematical equations.

The wastewater tax law in the Federal Republic of Germany distinguishes between two deductions for preexisting pollution in the receiving stream: the initial (basic) deduction, which applies only to suspended solids and COD; and the prepollution deduction, applicable to parameters relevant to wastewater effluent. Most states in the Federal Republic do not recognize additive consideration of prepollution, which gives them an unjustified advantage. The problem is that preexisting pollution (e.g., 5 mg COD/l) in a river is picked up by each user and is passed onto the next; it is usually not removed by wastewater treatment as it mainly consists of biologically and chemically inert matter, e.g., humic acid. Each user pays with his wastewater tax for pollution that upstream users have already paid for. In addition, downstream users are paying for extra pollutants introduced and paid for by upstream users that raise the level of preexisting pollution for the former. This phenomenon can be expressed mathematically. (Gish-IVI)
W84-05271

ROLE OF MACROPHYTES IN AQUATIC ECOSYSTEMS AND MANAGEMENT OF FRESHWATER RESOURCES,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
For primary bibliographic entry see Field 5A.
W84-05306

6G. Ecologic Impact Of Water Development

PRELIMINARY STUDY OF THE EFFECTS OF IMPOUNDMENT OF LG-2 RESERVOIR (JAMES BAY TERRITORY, QUEBEC) ON THE NET SESTON AND THE ZOOPLANKTON OF IMPOUNDED RIVERS AND LAKES (ETUDE PRELIMINAIRE DES EFFETS DE LA MISE EN EAU DU RESERVOIR DE LG-2 (TERRITOIRE DE LA BAIE JAMES, QUEBEC) SUR LE SESTON GROSSIER ET LE ZOOPLANKTON DES RIVIERES ET DES LACS INONDES),
Montreal Univ. (Quebec). Centre de Recherches Ecologiques.
B. Pinel-Alloul, and G. Methot.
Internationale Revue der Gesampten Hydrobiologie, Vol. 69, No. 1, p 57-78, 1984. 7 Fig, 6 Tab, 41 Ref.

Descriptors: *Reservoirs, *Zooplankton, *Seston, *Ecological effects, *James Bay Territory, Quebec, River La Grande, Environmental impact statement, LG2 reservoir, River basin development, Water resources development, Bacterioplankton, Allochthonous organic matter, Food chains.

The effects of impoundment on the biomass of net seston and zooplankton in lakes and rivers of Northern Quebec were investigated from 1978 to 1980, before, during and after the completion of LG2 Reservoir on the River La Grande. In lotic stations, a 41-77% decrease in net seston was observed due to sedimentation of mineral particles (36-80 mg/cu m in 1978 to 10-21 mg/cu m in 1979). The ratio of organic to total seston increased from an average of 0.18 before the impoundment to 0.65 after. The flooding phase brought about a trophic upsurge; the biomass of the zooplankton increased by one to two orders of magnitude at the various sites; the greatest increases occurred in the central station near the dam, the smallest in the upper stations near the inflow. In lake stations, no significant difference between years could be detected; the mean zooplankton biomass for all three years ranged from 6.59 mg/cu m to 34.34 mg/cu m. Spatial variations between lakes were however significant. Results are compared with those in other natural lakes in Canada and reservoirs in the United States. Comparative examination of phytoplankton biomass before and after impoundment of LG2 Reservoir suggests that bacterioplankton and allochthonous organic material are key elements in the pelagic food chain after impoundment. (Murphy-IVI)
W84-04894

ANTHROPOGENIC EFFECTS ON THE FISH POPULATION (ANTHROPOGENE EINWIRKUNGEN AUF FISCHBESTANDE),
Galati Univ. (Romania).
For primary bibliographic entry see Field 5C.
W84-04912

ENVIRONMENTAL ANALYSIS IN HYDROPOWER LICENSING: A MODEL FOR DECISION MAKING,
American Univ., Washington, DC. School of Government and Public Administration.
N. Kerwin.
Environmental Impact Assessment Review, Vol. 4, No. 2, p 131-136, June, 1983.

Descriptors: *Environmental impact statement, *Hydroelectric power, *Decision making, Planning, Management, Water resources development, Environmental effects, Powerplants.

The Federal Energy Regulatory Commission (FERC) must consider a number of aspects of a proposed hydropower project including the need for the power it generates, its safety and the affected environment. The environmental dimension of licensing is outlined by a complex network of Federal statutes which estabishes both substantive and procedural obligations for FERC. Environmental reports prepared by developers are incorporated into applications for project licenses. When applications are deemed acceptable for processing, the staff determines what type of report they will issue on the proposed project. The decision not to develop an impact statement could be significant if it meant no further analysis would be done. There are strong incentives for all interested parties to engage in an analytical process that isolates key issues early and in dispute resolution to reach negotiated agreements. There are two general types of environmental conditions that can be attached to a license for a hydropower project. One type is included among the so-called L form or standard license articles. It includes general requirements to provide for recreation, to prevent soil erosion, to dispose of spoil from construction properly and to install and maintain stream gauges. The other type involves special environmental articles developed specifically for individual projects. The FERC environmental analysis is a process that has moved perceptibly toward the decision-making model that experts hoped would emerge from the analytical requirements of NEPA. (Baker-IVI)
W84-05010

EFFECTS OF DISSOLVED-OXYGEN DEPLETION ON THE RAINBOW TROUT FISHERY IN LAKE TANEYCOMO, MISSOURI,
Missouri Dept. of Conservation, Columbia.
A. S. Weithman, and M. A. Haas.
Transactions of the American Fisheries Society, Vol. 113, No. 2, p 109-124, March, 1984. 7 Fig, 4 Tab, 8 Ref.

Descriptors: *Lake Taneycomo, *Missouri, *Dam effects, *Trout, *Dissolved oxygen, Fisheries, Sport fishing, Fishing success, Catch rate, Economic aspects.

Lake Taneycomo, a 700-hectare hydroelectric impoundment in Taney County, southwestern Missouri, is fed by cool hypolimnetic waters from an upstream reservoir. A popular put-grow-and-take fishery for rainbow trout Salmo gairdneri has become established in Lake Taneycomo, but fishing success and effort decline each fall when oxygen-depleted water enters the lake. The fishery was examined in detail from June 1978 through May 1980. During this period, catch rates of rainbow trout averaged 0.55 fish/hour, and were influenced by dissolved-oxygen concentration, number of fish available to be caught, discharge rates from the upstream reservoir, angler experience, and water temperature. A decrease of 1 mg/liter dissolved oxygen, between 6.0 and 2.4 mg/liter, reduced catch rates by 0.1 fish/hour. During the fall, a change in catch rate of 0.1 fish/hour can result in a change of 20,000 hours of fishing at Lake Taneycomo. The expected annual economic loss to the Taney County economy due to low concentrations

of dissolved oxygen is $358,000 (range $267,000-$432,000). (Author's abstract)
W84-05082

HABITAT USE BY ADULT PADDLEFISH IN THE UPPER MISSISSIPPI RIVER,
Iowa Cooperative Fishery Research Unit, Ames.
P. D. Southall, and W. A. Hubert.
Transactions of the American Fisheries Society, Vol. 113, No. 2, p 123-131, March, 1984. 3 Fig, 4 Tab, 31 Ref.

Descriptors: *Fish behavior, *Mississippi River, *Paddlefish, Aquatic habitats, Tailwaters, Channels, Backwater, Invertebrate drift, Environmental effects.

Information on paddlefish habitat associations in the upper Mississippi River is useful because of continuing adverse effects on habitat by navigation, siltation, and industrial siting, as well as potential hydroelectric power development. Seventeen paddlefish were tracked in two pools (12 and 13) of the upper Mississippi River during the summer of 1980 and spring and summer of 1981. Interpool movement occurred during spring high water periods when dam gates were lifted to create a free-flowing river. Habitat use varied by season. Selection was greatest for tailwater and channel habitats, although strong association with one backwater slough was evident. Even when backwaters are not directly utilized, invertebrate drift from these areas may be important. Paddlefish often congregated near man-made structures that created eddies and reduced current velocities. (Baker-IVI)
W84-05083

STATUS OF RIPARIAN ECOSYSTEMS IN THE UNITED STATES,
New York State Dept. of Environmental Conservation, Delmar. Div. of Fish and Wildlife.
For primary bibliographic entry see Field 2A.
W84-05162

CHANGES IN DIATOM FLORA DEPOSITED ANNUALLY DURING THE FRESHENING OF THE IMPOUNDED, SEA-BAY OF GENNARBY-VIKEN IN SOUTHERN FINLAND,
Turku Univ. (Finland). Dept. of Quaternary Geology.
For primary bibliographic entry see Field 2L.
W84-05220

IMPINGEMENT OF FISHES AT THE INDIANAPOLIS POWER AND LIGHT COMPANY GENERATING STATION ON THE WHITE RIVER AT PETERSBURG, INDIANA,
Indiana State Univ., Terre Haute. Dept. of Life Sciences.
J. O. Whitaker, Jr.
Procedings of the Indiana Academy of Sciences, Vol. 92, p 213-217, 1982. 5 Tab, 4 Ref.

Descriptors: *Fish, *Powerplants, Impingement, Deicers, White River, Petersburg, Indiana, Screens, Inflow channels, Channels.

Seines were placed across the impingement outflow trough and all fish were collected during extended sampling periods. The total number, number per hour, and projected number per year of all species of fish taken in the impingement sample are provided. These totaled 10,772 individuals, of which 9784 (90.8%) were gizzard shad, followed by the channel catfish 444 or 4.1% and buffalo at 149, or 1.4%. A total of 32 separate species were found. Relatively few fish are generally impinged. Most of the fish taken in the impingement samples were relatively small, less than 6 in. total length. Many were 2-4 in. long. There was some indication that the deicer, when in operation, might be attracting some fish that otherwise would not have been impinged, but further study is needed to corroborate this theory. (Baker-IVI)
W84-05307

7. RESOURCES DATA

7B. Data Acquisition

CONSTRUCTION AND OPERATION OF A LARGE UNDISTURBED LYSIMETER TO MEASURE RECHARGE TO THE CHALK AQUIFER, ENGLAND,
Institute of Hydrology, Wallingford (England).
R. Kitching, and T. R. Shearer.
Journal of Hydrology, Vol. 58, No. 3/4, p 267-277, September, 1982. 5 Fig, 6 Ref. U. K. Dept. of the Environment Contract No. DR6/480139.

Descriptors: *Measuring instruments, *Lysimeters, *Groundwater recharge, *England, Aquifers, Water balance, Chalk aquifers.

A large lysimeter has been successfully constructed and operated to yield continuously experimentally measured values of recharge throughout the whole year. The method is completely independent of sophisticated theoretical models of the recharge mechanism and in particular does not rely on imputed values of evaporation determined from empirical or other equations. The lysimeter has proved generally reliable and has yielded good data with a minimum of manual involvement indicating that the technique is suitable for use in remote locations. Comparisons with the Cambridge Water Company's shallow turfed lysimeter at the same site indicate that there are some differences in the timing and quantity of the recharge. So far, the differences have not been excessive but the characteristics of these differences indicate that the optimal size for a lysimeter is somewhat greater, particularly in depth, than these installations. (Baker-IVI)
W84-04851

APPLICATION OF HOT-WIRE (-FILM) FLOWMETERS TO WATER VELOCITY MEASUREMENTS IN WELLS,
Imperial Coll. of Science and Technology, London (England). Div. of Engineering Geology.
For primary bibliographic entry see Field 2E.
W84-04858

FIELD SYSTEM FOR AUTOMATICALLY MEASURING SOIL WATER POTENTIAL,
Alabama Agricultural Experiment Station, Auburn.
For primary bibliographic entry see Field 2G.
W84-04880

DETERMINING SOIL-INDUCED PLANT WATER POTENTIAL DEPRESSIONS IN ALFALFA BY MEANS OF INFRARED THERMOMETRY,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2I.
W84-04970

COMPARISON OF WATER STRESS OF COTTON FROM MEASUREMENTS WITH THE HYDRAULIC PRESS AND THE PRESSURE CHAMBER,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2I.
W84-04981

CHUTE ENTRANCES FOR HS, H, AND HL FLUMES,
Agricultural Research Service, Stillwater, OK. Crop Production and Water Conservation Lab.
W. R. Gwinn.
Journal of Hydraulic Engineering, Vol. 110, No. 5, p 587-603, May, 1984. 13 Fig, 4 Tab, 6 Ref, 2 Append.

Descriptors: *Flumes, *Chute entrances, *Flow measurement, Open channel flow, Runoff, Sediments, Hydraulic jump, Turbulence, Mixing.

The HS, H, and HL flumes have a proven performance for measuring runoff from watersheds and flows in open channels. In order to reduce problems with ponding and sediment deposition, new chute entrances were designed for the flumes. The flumes were calibrated with the new chute entrances in place for both free and submerges outfall conditions. Sediment was fed into the flow to evaluate chute entrance and flume performance when conveying sediment-laden flows. In the HL flume with a flat floor approach the discharge ranged from 6.5% below published table values for low flows to almost no difference at the maximum head. Generalized discharge equations for HS, H, and HL flames with chute entrances are given. A direct solution for the effect of submergence on HL flumes is presented in equation form. The hydraulic jump which forms on the sloping floor of the chute for all flows causes turbulence in the jump which helps keep sediment in suspension and provides mixing for water quality measurements. The depth of ponding over the approach is reduced to half of what it would be if no chute were provided. Sand in the flow will deposit at the lower end of the chute and in the flume. Discharge corrections are provided for sediment concentrations less than 11,000 mg/L (1.1%) in the HS flume with chute entrance and collector trough. (Moore-IVI)
W84-05146

DOCUMENTATION OF HIGH SUMMER FLOWS ON THE POTOMAC RIVER FROM THE WOOD ANATOMY OF ASH TREES,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W84-05165

TRENDS IN THE DEVELOPMENT OF HYDROMETRY,
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
O. Starosolszky.
Hydrological Sciences Journal, Vol. 28, No. 1, 3, p 103-123, 1983. 16 Fig, 1 Tab, 14 Ref.

Descriptors: *Measuring instruments, *Hydrometry, Reviews, Turbulent flow, Currents, Flow discharge, Network design, Data processing.

Developments in the field of operational hydrology concerning reliable and accurate instruments and methods of observation are reviewed. In assessing the trends, the interconnections of hydrometry with network design and data processing are discussed. Three-dimensional flow phenomena in streams and lakes present a challenge to hydrologists. Several aspects should be studied in order to get a better understanding of the problem of flow measurement. Some of these aspects include: variation of the rating curve of measuring structures; measurement of spatial velocity vectors at great depths; measurement of three-dimensional turbulence and minimizing its affect on the uncertainty of current metering; assessment of the magnitude of velocity pulsations and identification of their sources; recognition of three-dimensional flow as a source of bias in discharge measurement; and assessment and reduction of the uncertainty of flow measurement in lakes, and clarification of the actual meaning of the values measured. (Baker-IVI)
W84-05301

SOIL-WATER FLUX SENSOR AND ITS USE FOR FIELD STUDIES OF TRANSFER PROCESSES IN SURFACE SOIL,
Oita Univ. (Japan).
H. Kawanishi.
Journal of Hydrology, Vol. 60, No. 1-4, p 357-365, January, 1983. 6 Fig, 3 Ref.

Descriptors: *Rainfall, *Soil water, Evapotranspiration, Chlorides, Temperature, Heat, Infiltration, Measuring instruments.

A soil-water flux sensor was developed to determine the flux value from the difference between

downstream and upstream temperatures at some distances from an artificial line source of heat placed at a right angle to the water flow. It can detect flux values ranging from several mm/hr to as small as 0.01 mm/hr. Design and calibration of the sensor are described. The sensor was applied to the field studies of transfer processes in a surface soil, including rainwater infiltration, upward soil water flow during evapotranspiration, and their effects on the water table level. A cylindrical container of polyvinyl chloride, 70 cm in diameter and in depth, was buried with its top out of the soil and was provided with the same soil and the same grass cover as the surroundings. Groundwater table reached near the surface just after a heavy rain and descended gradually during a spell of fine weather. Observations of soil-water flux, soil-water content and water-table depth were carried out with the soil in the container. The soil-water flux sensor was buried just below the root zone at a depth of 15 cm. Soil was sampled at several depths to 15 cm, to determine the volumetric contents of water and solutes. The water table depth was recorded with a float type water level gauge. The evapotranspiration rate was determined by the heat balance method. Chloride ion accumulation in the surface soil is discussed on the basis of upward water flux and chloride content observed. (Baker-IVI)
W84-05366

EVAPORATION DATA FROM A PICHE EVAPORIMETER,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
For primary bibliographic entry see Field 2D.
W84-05367

7C. Evaluation, Processing and Publication

LINEAMENTS AND FRACTURE TRACES, DECATUR COUNTY, INDIANA,
Geological Survey, Indianapolis, IN. Water Resources Div.
T. K. Greeman.
USGS Open-File Report 82-918, 1983. 18 p, 4 Fig, 14 Ref.

Descriptors: *Aquifer characteristics, Drilling, *Geological fractures, Groundwater movement, Potential water supply, *Fracture trace, *Lineament, Limestone-dolomite aquifer, Well-site selection, Drift fractures, *Indiana, Decatur County.

Lineaments and fracture traces were mapped in Decatur County. Observed throughout the county, these features overlie vertical bedrock fractures. Wells drilled on these mapped features may yield adequate supplies for domestic and larger needs. Two nearly horizontal sequences of mid-Paleozoic limestone and dolomite, separated by a thin discontinuous shale unit, constitute the principal aquifer. Many wells in this aquifer fail to supply household needs, whereas others are used for municipal supply. Wells in the aquifer have been located for the owner's convenience and are randomly located in relation to lineaments and fracture traces. Pleistocene glacial drift, averaging about 150 feet thick, did not restrict lineament and fracture-trace mapping. Well placement is very important in this area, as fractures are a principal source of water to wells. In fractured bedrock areas, the most productive well locations are at mapped lineament or fracture-trace intersections and at the lowest local altitude. Use of the lineament and fracture-trace map will not guarantee a sufficient ground-water supply, but will minimize the chance of drilling an inadequate well. (USGS)
W84-04806

SOME METHODS FOR TESTING THE HOMOGENEITY OF RAINFALL RECORDS,
Royal Netherlands Meteorological Inst., De Bilt.
T. A. Buishand.
Journal of Hydrology, Vol. 58, No. 1-2, p 11-27, August, 1982. 8 Fig, 4 Tab, 17 Ref.

Descriptors: *Rainfall, *Homogeneity, *Netherlands, Mathematical equations, Data collections, Cumulative deviation.

Cumulative deviations from the mean are often used in the analysis of homogeneity of rainfall records. Features of five tests on the cumulative deviations are discussed. Some of these tests have optimal properties in testing the null hypothesis of homogeneity against a shift in the mean at an unknown point. As a first example two tests on the rescaled adjusted partial sums were introduced. Weighted cumulative deviations were discussed to emphasize changes near the end-points of the sequence. Worsley's likelihood ratio test for a shift in the mean in normal populations is equivalent to a test on the weighted adjusted partial sums. Bayesian procedures for testing a change in level were described. The resulting test-statistics are simple quadratic forms of the rescaled adjusted partial sums. The data generation method showed that tests on the cumulative deviations are superior to the classical von Neumann ratio for a model with only one change in the mean. The tests were applied to annual data for 264 rainfall stations in The Netherlands. There was strong evidence of departures from homogeneity. The von Neumann ratio gave nearly the same results as the tests on the cumulative deviations. (Baker-IVI)
W84-04836

8. ENGINEERING WORKS

8A. Structures

OPTIMAL DIAMETER SELECTION FOR PIPE NETWORKS,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
R. E. Featherstone, and K. K. El-Jumaily.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 221-234, February, 1983. 4 fig, 6 Tab, 9 Ref.

Descriptors: *Optimization, *Pipe diameters, *Pipelines, Systems analysis, Network design, Pipe distribution networks, Mathematical equations, Operating costs.

A new approach to the least cost design of water distribution networks has been developed. The method is based on traditional techniques of pipe networks analysis by computer; initially assumed pipe diameters are successively adjusted using an optimization technique which is based on a cost function incorporating the various capital and operating costs. Final design total costs for a given network have been found to be approximately the same regardless of the initially assumed values of pipe diameter although the final arrangements of pipe diameter are not necessarily identical. Since the method considers all physical components of the network, both from the point of view of the flow and pressure distribution and the costs, the design represents the global optimum as opposed to a typical element optimum which has been considered by other workers. The method contains no constraints such as assumed fixed pressure heads or pipe flows and may be applied to either closed loop or open loop networks of any size. Provided a computer program for analyzing pipe networks is available, the optimization technique developed represents a simple addition to the basic program. (Author's abstract)
W84-04830

IDEAL RESERVOIR CAPACITY AS A FUNCTION OF YIELD AND RISK,
Technical Univ. of Istanbul (Turkey). Dept. of Hydraulics and Water Power.
M. Bayazit.
Journal of Hydrology, Vol. 58, No. 1/2, p 1-9, August, 1982. 12 Fig, 4 Ref.

Descriptors: *Reservoir capacity, *Deficit, *Yield, *Risk, Statistical analysis, Flow, Storage reservoirs.

Deficit represents the capacity of an ideal storage reservoir, which is allowed to spill, that can regulate the flow to supply a certain yield along a given period of time. Its statistical properties have been determined in this study by means of the data generation method. Simulation experiments have led to the conclusion that the standard form of the deficit has a unique distribution, whatever values the level and period of regulation, and autocorrelation coefficient of inflows have. Mean and standard deviation of the deficit have been determined as functions of the above variables. By means of the diagrams provided it is possible to determine the size of an ideal reservoir constant yield over a certain period of time with a given level of risk when it is assumed that flows into the reservoir constitute a first-order autoregressive process. (Baker-IVI)
W84-04835

RIVER LOCK REHAB: A WINTER'S TALE,
Harza Engineering Co., Chicago, IL.
J. T. Passage, and J. H. Plump, Jr.
Civil Engineering, Vol. 54, No. 5, p 44-47, May, 1984. 6 Fig.

Descriptors: *Dam construction, *Rehabilitation, *Locks, *Mississippi River, Safety, Construction, Blasting, Costs, Cold weather construction.

Lock and Dam No. 1 between St. Paul and Minneapolis on the Mississippi River had deteriorated past the point of safety and steps were needed to allow safe operation and at the same time not interrupt the summer flow of river traffic. Lock rehabilitation required a new filling and emptying system, replacement of deteriorated concrete, installation of post-tensioned anchors through the lock walls for stability, plus complete replacement of operating machinery, power supply and control systems. The apron slab of the overflow spillway dam also required anchoring with post tensioned anchors and the replacement of some deteriorated concrete. Turbulence had to be reduced in the lock chamber during filling and downstream of the lock during emptying in order to improve hydraulic efficiency and increase safety. Controlled blasting was used to carefully remove the concrete in the culverts, to replace the face of the lock walls and to remove monoliths of concrete as large as 30 ft wide, 30 ft deep and 60 ft high, necessary to modify the filling and emptying system. Before rehabilitation, discharge from the land wall was directed across the navigation channel and discharge from the center wall flowed straight down the channel, causing considerable turbulence in the areas where commercial vessels and pleasure craft wait to approach the locks. Modifications were made to this procedure. The locks and dam were rehabilitated for a final design and construction cost of $45 million - less than a quarter of the cost of a new structure. (Baker-IVI)
W84-04925

RECENT DEVELOPMENTS IN THE FIELD OF FRENCH ENGINEERING RELATING TO HYDRO-ELECTRIC GENERATION (LES RECENTS DEVELOPPEMENTS DANS LE DOMAINE DE L'INGENIERIE FRANCAISE EN MATIERE D'ENERGIE HYDROELECTRIQUE),
H. de Maublanc.
La Houille Blanche, Vol. 5/6, p 393-402, 1982. 5 Fig, 1 Tab.

Descriptors: *France, *Hydroelectric plants, *Civil engineering, Dam design, Hydraulic machinery, Dam construction, Computers, Construction methods, Intakes, Tunnel construction, Tidal energy.

In civil engineering in France, important developments in techniques have been made in: design (concrete dams, ski-jump spillways in narrow valleys, progress in the construction of arches in large valleys, use of confined flow spillways, embankment dams, sealing systems and the treatment of foundations); computations (use of computer and semi-probabilistic methods); construction (construction of mobile dams on dry land, and construction underwater without deponding the foundations). The design of water intake structures fitted with automatic scours has solved the prob-

lem of intake structures at high altitudes. Tunnelling machines are already in use in France on major projects, and are increasingly used for boring galleries and tilted shafts. For underground stations, developments have been in design, boring, and earth retaining techniques. Feasibility studies for tidal energy are presently underway. Recent developments in electromechanical equipment are chiefly linked to the enhancement of the characteristics of sets (unit power, head, rotational speed) and their operating mode (automatic systems and remote control, secondary regulation of frequency and voltage). Some progress has also been made in the generator motor field and confined flow conduits. (Moore-IVI)
W84-05018

INTEGRATED DEVELOPMENT OF A LARGE RIVER: THE RHONE; A. GENERAL DESIGN AND EFFECT ON FLOODS AND SUBSURFACE WATER LAYERS (L'AMENAGEMENT INTEGRE D'UN GRAND FLEUVE: LE RHONE; A. CONCEPTION GENERALE ET EFFETS SUR LES CRUES ET LES NAPPES PHREATIQUES),
Compagnie Nationale du Rhone, Lyon (France).
P. Savey.
La Houille Blanche, Vol. 5/6, p 421-426, 1982. 6 Fig, 3 Ref.

Descriptors: *Rhone River, *France, *Water resources development, Navigation, Hydroelectic plants, Agricultural development, Flood control, Drainage, Dredging, Groundwater management.

Responsibility for the development of 500 km of the French part of the Rhone is in the hands of the National Rhone Corporation (CNR). The operation is almost complete, with 16 of the 19 locations to be harnessed already in service. This is a multi-purpose development for hydroelectric generation, navigation, agricultural development, flood protection and development of port facilities. The Rhone has promising potential with a semi-permanent flow of 1460 cu m/s, conveying a average of 50 billion cu m per year. It produced 16.9 TWh in 1981. The navigable section completed as of 1981 is 350 km long and can handle the passage of 4,000 to 5,000 ton convoys. The waterway has been divided into 19 sections. The least land possible has been absorbed for each section in order to promote the development of the riverside economy. Special measures (dyking, dredging and automated operation) taken to ensure the offtake of floodwater, have produced a marked improvement over natural conditions. In addition, major drainage facilities have allowed for control of subsurface water layers in the valley for the needs of farming and riverside towns. The continuity of the work (spread over 30 years) and the fact that the CNR is both designer and operator, have made it possible for this development to benefit from the significant technological progress which has occurred in recent decades. (Moore-IVI)
W84-05019

INTEGRATED DEVELOPMENT OF A LARGE RIVER: THE RHONE; B. DEVELOPMENT OF ELECTRO-MECHANICAL EQUIPMENTS (L'AMENAGEMENT INTEGRE D'UN GRAND FLEUVE: LE RHONE; B. EVOLUTION DES EQUIPEMENTS ELECTROMECANIQUES),
Compagnie Nationale du Rhone, Lyon (France).
For primary bibliographic entry see Field 8C.
W84-05020

HYDRO-ELECTRIC RESOURCES OF THE PARANA RIVER IN BRAZIL (LES RESSOURCES HYDROELECTRIQUES DU PARANA BRESILIEN),
C. A. de P. Amarante.
La Houille Blanche, Vol. 5/6, p 451-460, 1982. 3 Fig, 3 Tab.

Descriptors: *Parana River, *Brazil, *Hydroelectric plants, Water resources development, Itaipu Project.

The hydrographic basin of the Parana river occupies 1,237,000 sq km of the most developed region in the center of Brazil. A full inventory was made over the 1960's which was the basis for its later development: the Parana is now harnessed by more than twenty large hydro-electric power stations in operation with a total installed power of 20,000 MW. Their main characteristics and the resources remaining to be harnessed will give an idea of the importance of the Parana river in the development of hydro-electric sites in Brazil. The Itaipu development presently under way (126,000 MW) is mentioned in particular as a joint project between Brazil and Paraguay. (Author's abstract)
W84-05021

WORKSITE OF THE GRAND'MAISON DAM (LE CHANTIER DE CONSTRUCTION DU BARRAGE DE GRAND'MAISON),
J. Cadot.
La Houille Blanche, Vol. 5/6, p 487-496, 1982. 5 Fig, 1 Tab.

Descriptors: *Grand'Maison Dam, *Dam construction, *Earthworks, *Rockfill dams, Cold weather construction, Alpine regions, Embankments, Construction equipment.

The Grand'Maison dam, at a height of 1700 m, is formed of an earth dyke and rockfill built up 160 m from the ground for a total volume of 125000000 cu m. The construction of the facility will take sixty-nine months of elapsed time, but the climatic conditions of this mountain site, which is snowed up most of the year, limits actual construction time to approximately 85 summer days each year. The seasonal character of the worksite has determined the organization of the work and the choice of the means used by the group of firms building the dam. The refilling embankments (rockfill upstream and screen downstream) are constructed using conventional earthwork equipment: pneumatic loading machine, hydraulic buckets on high-capacity caterpillars, and 50-ton dumpers. A 1250 m conveyor belt with a carrying capacity of 1500 tons/hour conveys the materials used for the core. It crosses a large ravine on a 90 m metallic gangway. The segregation of materials is avoided by the use of a specially designed laige hopper. (Author's abstract)
W84-05023

PRESSURE AND SPEED MEASUREMENTS IN A CENTRIFUGAL FAN (ROTOR AND STATOR) BEFORE AND AFTER THE APPEARANCE AND DISAPPEARANCE OF ROTATING STALLS (MESURES DE PRESSIONS ET DE VITESSES DANS UN VENTILATEUR CENTRIFUGE (ROTOR ET STATOR) AVANT ET APRES L'APPARITION ET LA DISPARITION DES DECOLLEMENTS TOURNANTS),
Ecole Nationale Superieure des Arts et Metiers, Lille (France).
B. Desmet.
La Houille Blanche, Vol. 2/3, p 167-174, 1982. 19 Fig, 10 Ref.

Descriptors: *Rotating stalls, *Hydraulic models, *Centrifugal pumps, Turbines, Impeller blades, Discontinuity, Rotation speed, Flow structure.

A centrifugal fan research facility was designed for pressure measurements on impeller blades. At low flow rates, a zone of discontinuity can be observed in the variation of head coefficient, power coefficient, and efficiency with the flow coefficient. The frequency response of the blade pressure measuring device was determined experimentally using the time response to a pressure step. the blade pressure fluctuations increase when the rotating stall appears, especially on the suction side at the inlet of the blade. Relative rotation speed of the rotating stall is deduced from the frequency analysis of pressure flutuation. The number of stall zones and the ratio of rotation speed of the rotating stall to that of the impeller as a function of the rate of flow is studied using one or two hot wire probes, placed at the impeller inlet, checking that the characteristics do not change when the fan rotates at a speed between 1000 and 2500 r.p.m. The blade to blade to blade distribution of speeds at impeller outlet over the whole width of the channel is obtained by using a probe with two hot wires. The flow structure with jet and wake can be observed at the center of the channel and the flow is more uniform near the hub and shroud. (Moore-IVI)
W84-05029

ESTIMATING GATE WEIGHTS,
Internacional de Engenharia, Rio de Janeiro (Brazil).
P. C. Erbiste.
International Water Power and Dam Construction, Vol. 36, No. 5, p 18-23, May, 1984. 7 Fig, 9 Tab, 5 Ref.

Descriptors: *Gates, *Weight, Dam construction, Construction, Estimating, Spillway gates, Fixed wheel gates, Tainter gates, Stoplogs, Flap gates.

A method is described for estimating the weight of gates based on their nominal dimensions and the head on the sill. Data are included on new types of gates. The gate weight directly affects the capacity of the hoisting equipment, and the final cost of supply to a construction project is generally estimated on the basis of the total weight of the equipment, of which the weight of the gate is the biggest concern. In order to determine the weight of the gate it is necessary to calculate the hydraulic forces, loading on members, working stresses, bolted and welded connections, pivots and supports and last, the gate weight. Equations are provided in this paper for estimating the weight of the following types of gates: spillway and submerged tainter gates, fixed-wheel gates, double-leaf fixed wheel gates, spillway and submerged stoplogs and flap gates. For each type an expression involving only the nominal gate dimensions and the head on the sill is developed, as these are generally the only defined characteristics at the start of a project. (Baker-IVI)
W84-05098

USE AND RE-USE OF ITAIPU'S DIVERSION GATES,
Itaipu Binacional, Rio de Janeiro (Brazil).
J. R. Villalba, R. C. Monteiro, A. E. Raiunec, J. H. Gummer, and J. P. Baroux.
International Water Power and Dam Construction, Vol. 36, No. 5, p 24-28, May, 1984, 9 Fig, 1 Tab.

Descriptors: *Dam construction, *Diversion, *Gates, *Itaipu, Design criteria, Planning, Water management, Flow, Construction, Parana River, Intake gates.

The choice of materials for Itaipu's diversion gates, their design and mode of construction are described, as well as the operation to recover them after diversion closure for re-use as intake gates. The diversion structure and its associated sluices were designed in such a way that for a maximum flow of 35,000 cub m/sec, the main upstream cofferdam at el. 140 m would not be overtopped and the velocity in the sluices would not exceed 15 m/s to limit any possible cavitation or abrasion damage. Also the design of the diversion had to allow for the riparian rights in the Parana River to be maintained during closure. In the initial scheme the diversion gates were to be used solely for diversion and left in place after closure and permanent concrete plugs were to be placed in the diversion sluices. However, as the design of the gates progressed, it was realized that substantial savings could be made if the gates were rehabilitated and subsequently used in the power intakes. (Baker-IVI)
W84-05099

CONJUNCTIVE USE OF DETERMINISTIC AND STOCHASTIC MODELS FOR PREDICTING SEDIMENT STORAGE IN LARGE RESERVOIRS; 1. A STOCHASTIC SEDIMENT STORAGE MODEL,
Pontificia Univ. Catolica do Rio de Janeiro (Brazil).
E. F. Soares, T. E. Unny, and W. C. Lennox.
Journal of Hydrology, Vol. 59, No. 1-2, p 49-82, October, 1982. 5 Fig, 14 Tab, 24 Ref, 3 Append.

Descriptors: *Stochastic process, *Sediment storage, *Reservoir silting, *John Martin Reservoir,

•Colorado, Dam effects, Model studies, Sediment deposition.

When a dam is constructed in a natural water course to store water, it changes the hydraulic characteristics of flow immediately upstream of the dam and, consequently, the sediment-transport capacity. Sedimentation of the reservoir created by the dam is then inevitable, reducing the storage capacity of the reservoir. In planning reservoirs, it is necessary to predict not just the probable amount of total sediment stored, but also how this stored sediment is distributed along the reservoir. A stochastic model is developed to predict the deposition of sediment in reservoirs as a function of time in years. The cumulative deposition of sediment in time is an additive process defined on a finite Markov chain. The model is analyzed to obtain the mean and the range of the cumulative deposition as a function of discrete time in years. The model is applied to describe the sediment storage in the John Martin Reservoir, on the Arkansas River in Colorado. The reservoir was constructed for flood control and irrigation. The sediment accumulated in the reservoir at the end of each water year as computed by the suspended load at inflow and outflow stations from the years 1943-1966, and the sediment accumulated in the reservoir as computed from sediment surveys are compared. The stochastic model is capable of predicting the cumulation of sediment deposition in the reservoir. The measured values are found to be derived from a population that has the expected value and variance specified by the model. (Moore-IVI)
W84-05127

CONJUNCTIVE USE OF DETERMINISTIC AND STOCHASTIC MODELS FOR PREDICTING SEDIMENT STORAGE IN LARGE RESERVOIRS: 2. DETERMINISTIC MODEL FOR THE SEDIMENT DEPOSITION PROCESS,
Pontificia Univ. Catolica do Rio de Janeiro (Brazil).
E. F. Soares, T. E. Unny, and W. C. Lennox.
Journal of Hydrology, Vol. 59, No. 1-2, p 83-105, October, 1982. 7 Fig, 29 Ref.

Descriptors: •Reservoir silting, •Model studies, •Sediment deposition, Deterministic models, Distribution, Dam effects, Stochastic process, Sediment storage.

The stochastic model developed in Part 1 could be use to determine the distribution of sediment along the length of the reservoir, if the quantity of sediment deposited in a time period was determined as a function of the length measured from the upstream end of the reservoir. This functional relationship is formulated by developing a mode describing the unsteady free-surface flow of sediment-laden water over a loose bed. The governing equations are solved using an implicit finite-difference scheme. The pattern of deposition is a function of the inflow and the concentration of sediment in the inflow as well as the initial level in the reservoir and the initial composition of the sediment. The inflow in the reservoir is treated as unsteady and non-uniform. As much of the physical characteristics of the reservoir as possible is included in the analysis. (Moore-IVI)
W84-05128

CONJUNCTIVE USE OF DETERMINISTIC AND STOCHASTIC MODELS FOR PREDICTING SEDIMENT STORAGE IN LARGE RESERVOIRS; 3. APPLICATION OF THE TWO MODELS IN CONJUNCTION,
Pontificia Univ. Catolica do Rio de Janeiro (Brazil).
E. F. Soares, T. E. Unny, and W. C. Lennox.
Journal of Hydrology, Vol. 59, No. 1-2, p 107-121, October, 1982. 4 Fig, 11 Tab, 4 Ref.

Descriptors: •Reservoir silting, •Sediment deposition, •Model studies, •John Martin Reservoir, •Colorado, Stochastic process, Deterministic models, Sediment storage, Distribution, Dam effects.

The John Martin Reservoir is located on the Arkansas River in Bent County, Colorado. It is a multiple-purpose reservoir project constructed for flood control and irrigation. The stochastic sediment storage model developed in Part 1, in spite of the simple inflow representation adopted, predicted satisfactorily the total volume of sediment deposition as a function of time for the reservoir analyzed. In order to apply the model to predict sedimentation in new reservoirs, the parameters characterizing the inflow and the concentration of sediment in the inflow are required. These parameters can be easily evaluated if necessary measurements are carried out before the construction of the dam. The deterministic model developed in Part 2 appears, in the light of results obtained, adequate. This model may be used separately in unsteady non-uniform flow analysis with sediment discharge. A method has also been detailed to obtain the valid initial values for the problem. The combined deterministic-stochastic model satisfies the requirements for a realistic prediction of sediment distribution required for design of large reservoirs. (Moore-IVI)
W84-05129

BREACHING CHARACTERISTICS OF DAM FAILURES,
Leedshill-Herkenhoff, Inc., San Franciso, CA.
T. C. MacDonald, and J. Langridge-Monopolis.
Journal of Hydraulic Engineering, Vol. 110, No. 5, p 567-586, May, 1984. 3 Fig, 3 Tab, 56 Ref, 2 Append.

Descriptors: •Dam failure, •Computer programs, •Earth dams, Dam breaches, Safety, Dam stability, Erosion.

Computer programs have been developed that simulate dam break hydrographs, and route these hydrographs downstream so that inundated areas, flow depths, and flow velocities can be estimated. The programs are dependent on certain inputs regarding the geometric and temporal characteristics of the dam breach. Data on 42 historical dam failures were collected and analyzed to develop relationships which would form the basis of a methodology for estimating the geometric and temporal characteristics of breaches. Both earthfill dams, in which breaches are formed by erosion of the embankment material, and non-earthfill dams, that may have failed partly due to erosion and partly due to sudden collapses caused by instabilities, were studied. For both types of dams, the breach shape can be assumed to be triangular with 2V:1H side slopes if the breach does not extend to the base of the embankment and trapezoidal with 2V:1H side slopes if additional material is washed away after the breach reaches the base of the embankment. A methodology was developed for estimating the geometric and temporal characteristics of breaches in earthfill dams. These characteristics and methodology are compatible with existing computer programs and can be used in dam safety studies to estimate outflows from hypothetical dam failures. (Moore-IVI)
W84-05145

DEVELOPMENT OF THE WESTERN TIGRIS-BASIN IN TURKEY (AUSBAU DES WESTLICHEN TIGRIS-BECKENS IN DER TURKEI),
9 Eylul Univ., Izmir (Turkey). Dept. of Engineering and Architecture.
For primary bibliographic entry see Field 4A.
W84-05237

HYDRAULIC AND OPERATIONAL ASPECTS FOR THE ENERGY RECOVERY CONCEPT APPLIED AT THE WATER RESERVOIR SCHONBUHL OF THE LANDESWASSERVERSORGUNG STUTTGART (HYDRAULISCHE UND BETRIEBLICHE ASPEKTE DER ENERGIERUCKGEWINNUNGS - ANLAGE SCHONBUHL DES ZWECKVERBANDES LANDESWASSERVERSORGUNG),
Zweckverband Landeswasserversorgung, Stuttgart (Germany, F.R.).
For primary bibliographic entry see Field 8B.
W84-05247

TINAJONES PROJECT IN PERU (PART I) (DAS TINAJONES-PROJEKT IN PERU (TEIL I)),
Salzgitter A.G. (Germany, F.R.).
W. Strumm.
Wasserwirtschaft, Vol. 73, No. 9, p 275-278, 1983. 4 Fig, 2 Ref.

Descriptors: •Tinajones Project, •Peru, •Irrigation programs, Drainage, Reservoirs, Canals, Diversion structures, Water resources development.

The Tinajones project in the north of Peru must be viewed as one of the most important irrigation schemes in South America. The first phase of this project is now approaching completion. A reservoir with a capacity of 300 million cu m, appurtenant structures, and intake and outlet canals to exploit the available water resources, and also transandean diversions to increase the annual amount of water have already been finished, thus ensuring that water can be provided for an irrigation zone of around 60,000 ha. A large part of the proposed structures in the irrigation and drainage area have also already been completed. This paper gives a review of this project and describes some of the problems encountered along the way. (Author's abstract)
W84-05250

TINAJONES PROJECT PART II (DAS TINAJONES-PROJEKT TEIL II),
Salzgitter A.G. (Germany, F.R.).
W. Strumm.
Wasserwirtschaft, Vol. 73, No. 10, p 344-348, October 1983. 3 Fig, 3 Tab, 2 Ref.

Descriptors: •Tina Jones Project, •Irrigation programs, •Peru, •West Germany, Reclaimed water, Water supply development, Water supply systems, Water resources development, Saline water intrusion, Irrigation canals, Canal construction, Foreign Construction, Tunnel construction, Construction costs, Optimum development plans, Water management, Conchano River, Chotano River, Chancay River, Amazon catchment.

The aspects of the West-German-Peruvian Tina Jones irrigation Project in northern Peru are described. Construction of drainage channels in the irrigated area was necessary due to salt accumulation: in 1980, about 30% of the area suitable for agriculture had suffered damage by salt. In the Ferrenafe sector, 271.8 km of drainage channels and sewers were built between 1977 and 1981 at a cost of 16.5 million dollars by a Peruvian company. In the Mochumi subsector, a Peruvian firm built 29.0 km of drains for approximately 1.0 million dollars in 1980/81 with the assistance of a German construction supervisor. Drains in the Lambayeque sector totaled 168.4 km and cost 12.0 million dollars. In addition, a series of irrigation measures, which would cost about 1.0 million dollars were recommended, even though the concept of the project did not include supplementary irrigation. Construction of a 4.2-km tunnel to divert water from the Conchano River in the Amazon catchment area to the Chotano, which flows into the Pacific Ocean, provided water for 8,000 ha of land. The tunnel has an inner diameter of 2.5 m and a minimal flow of 13.0 cu m/sec; it was built in 1973-75 at a cost of about 27.0 million dollars; German advisors included an engineer-geologist, a tunnel builder, and a grouting expert. The key structure for Stage II of the project, diverting water from the Chotano to the Chancay River, was completed in 1956 after 7 yr of work. Severe erosion along its entire length was discovered in 1967, necessitating renovations of the tunnel (grouting; renewal and improvement of the floor) and associated structures. A Peruvian-German consortium undertook the work in 1980/81 at a cost of 16 million dollars. For the future, agricultural conditions in the Chancay valley must be optimized through reclamation of salt-damaged land, renovation of the irrigation system improvements within the agricultural industry and in marketing and credit, and optimal water-management planning. A German company is presently updating hydrological and water-management data and plans for Stage II, and is study-

ing the feasability of a reservoir for the Chotano catchment area. (Gish-IVI)
W84-05254

BUTTRESS POWER STATION NUBDORF ON INN (DAS PFEILERKRAFTWERK NUSSDORF AM INN),
Innwerk A.G., Nussdorf (Germany, F.R.).
L. Carl, and H. P. Hack.
Wasserwirtschaft, Vol. 73, No. 12, p 494-498, 1983. 8 Fig, 4 Ref.

Descriptors: *Buttress power station, *Nussdorf on Inn, *Inn River, Hydraulic efficiency, Hydraulic design, Hydraulic structures, Hydroelectric plants, Engineering aspects.

The new power plant of the Innwerk AG near Nussdorf on the river Inn was built as a buttress power station contrary to the conventional block type arrangement which is normally used in the layout of run off river power plants. By using buttress power stations the total volume of the structure and the settlements are reduced. Further the factors of safety against sliding and overturning and the hydraulic efficiency may be improved. (Author's abstract)
W84-05266

DESIGN OF HIGH-PRESSURE TUNNEL OUTLETS (BESONDERE ASPEKTE DER GESTALTUNG VON GRUNDABLASSEN IN STOLLEN),
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
G. Anastasi.
Wasserwirtschaft, Vol. 73, No. 12, p 501-509, 1983. 12 Fig, 19 Ref.

Descriptors: *Hydraulic design, *Outlets, *San Roque Dam, Flow patterns, Flow profiles, Flow system, Concrete dams, Pressure depression, Shock waves, Air demand, Air entrainment, Design criteria, Hydraulic models, Philippines.

High-pressure outlets in tunnels give more design problems than common bottom outlets in concrete dams. This report deals with problems related to pressure depressions upstream of the gates, to shock waves in the tunnel, to air demand and air entrainment with particular emphasis on flow aeration. Design criteria for these matters are supported by the result of a hydraulic model study. (Author's abstract)
W84-05267

8B. Hydraulics

MEASURED SOIL RESPONSE TO EPB SHIELD TUNNELING,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
G. W. Clough, B. P. Sweeney, and R. J. Finno.
Journal of Geotechnical Engineering, Vol. 109, No. 2, p 131-149, February, 1983. 15 Fig, 1 Tab, 13 Ref.

Descriptors: *Earth pressure balance, *Infiltration, *Shield tunneling, Tunneling, Tunnel hydraulics, Tunnel construction, Soil water, Seepage, Groundwater control, Soil Engineering, Construction methods.

In the past decade, tunneling in soil has been plagued by rapidly rising costs associated with control of groundwater and by demands that ground movements induced by tunneling be kept to small levels. The first earth pressure balance (EPB) shield project in the United States, a 3,000 ft (915 m) long, 12.1 ft (3.7 m) diameter, tunnel is described. It is located in San Francisco and passes beneath a heavily trafficked commercial area known as Fisherman's Wharf. The soil profile consists of 20 ft (6.1 m) of rubble fill which overlies a 30 ft (9.1 m) layer of Bay Mud. A colluvium layer underlies the Bay Mud. The tunnel section is located within the Bay Mud, and has a cover of approximately 30 ft (9.1 m); water heads above the crown are typically 15 ft (4.5 m). The EPB shield was designed to deal with these difficult ground conditions without the use of compressed air or dewatering, and to cut through numerous abandoned wooden piles along the route. Surface and subsurface ground movements were monitored along the alignment during and after shield passage. The shield was found to initially heave the soil aside slightly as the face passed, but movements thereafter were towards the tunnel. Settlements were typically less than for conventionally shields and, the ground water table was unaffected by tunneling. (Murphy-IVI)
W84-04811

ANALYSES OF FLOW FAILURES OF MINE TAILINGS DAMS,
Texas A and M Univ., College Station.
For primary bibliographic entry see Field 8D.
W84-04812

INVESTIGATION OF FLOW FAILURES OF TAILINGS DAMS,
Texas A and M Univ., College Station.
For primary bibliographic entry see Field 8D.
W84-04813

OPEN CHANNEL TRANSITIONS: RATIONAL METHOD OF DESIGN,
Roorkee Univ. (India).
N. Vittal, and V. V. Chiranjeevi.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p 99-115, January, 1983. 6 fig, 2 Tab, 9 Ref.

Descriptors: *Open channels, *Design criteria, *Transition flow, Tranquil flow, Flow characteristics, Hydrodynamics, Flow profiles, Mathematical equations.

In engineering practice, it is often necessary to connect a channel of rectangular cross section (the flume) to a channel of trapezoidal cross section (the channel) or vice versa. The connecting section providing the gradual cross-sectional change is known as the transition. The design of transition calls for minimal hydraulic losses in the transition. Existing methods for the design of an open channel transition between a rectangular flume and a trapezoidal channel for subcritical flow have been critically examined. Arising out of some fundamental considerations, a suggestion has been offered to make Hinds transition design a direct method. The problem of flow through open channel transitions has been viewed basically from the fluid mechanics point of view and suitable functions for the boundaries of transition (namely bed width, bed elevation, and side slope) have been identified partly analytically and partly experimentally. Based on these results, a new and rational method of design is suggested. (Murphy-IVI)
W84-04826

AIR VOIDS AT DOWNSHAFT-TUNNEL BENDS,
Central Electricity Generating Board, Leatherhead (England). Central Electricity Research Labs.
B. T. Goldring.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 189-198, February, 1983. 7 Fig, 8 Ref.

Descriptors: *Air voids, *Downshaft-tunnel, *Tunnel hydraulics, Tunnel bends, Flow profiles, Hydrodynamics, Flow characteristics, Pipe flow, Pipelines, Mathematical equations, Prediction, Void space.

In closed conduit water flows containing a small amount of free air, an air void can form at a bend which connects a vertical shaft to a horizontal tunnel. A sudden reduction in the water flow rate can cause this void to vent back up the shaft. Tests were conducted on eight perspex pipe bends whose center-line radius varied from 0.5 times-1.5 times the pipe diam, and over a range of pipe diameters from 2.8 in.-7.5 in. (0.072 m-0.190 m). The air volumetric flow rate was up to 2% of the water volumetric flow rate. A combined theoretical and analytical approach yielded equations which can be used to predict void formation and venting at a downshaft-tunnel bend. Extrapolation of the results shows that these voids will not occur in large diameter bends with moderate air flows. (Author's abstract)
W84-04828

PLUME DILUTION FOR DIFFUSERS WITH MULTIPORT RISERS,
California Inst. of Tech., Pasadena. W.M. Keck Lab. of Engineering Materials.
M. S. Isaacson, R. C. Y. Koh, and N. H. Brooks.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 199-220, February, 1983. 9 Fig, 4 Tab, 11 Ref.

Descriptors: *Plume dilution, *Diffusers, *Multiport risers, *Design criteria, *Wastewater disposal, Wastewater dilution, Wastewater management, Plumes, Hydraulic models, Wastewater diffusers, Outfall, Performance evaluation, San Francisco, California.

A group of three new outfalls with multiport diffusers has been designed for the discharge of waste into the Pacific Ocean off the west side of the San Francisco peninsula near Lake Merced. The near field plume dilutions from ocean outfall line diffusers consisting of evenly spaced risers with clusters of two to eight ports per riser have been measured in a two-dimensional sectional hydraulic model. Tests were run under both idealized and measured ocean current and stratification conditions. A mathematical model was successfully correlated with tests not involving ambient currents, thus providing a useful design tool. The laboratory results show that, for the cases studied, the initial dilution is at most a weak function of whether the discharge ports are clustered or evenly distributed along the diffuser, and that the minimum dilution increases with decreasing port size (limited, ultimately, to that of a line source). Therefore, the most cost effective design for riser equipped ocean wastewater diffusers may involve the smallest port diameters permitted by other design considerations, and clustering many ports per riser to decrease the number of risers needed. (Murphy-IVI)
W84-04829

VELOCITY DISTRIBUTION IN SMOOTH RECTANGULAR OPEN CHANNELS,
Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
K. V. N. Sarma, P. Lakshminarayana, and N. S. Lakshmana Rao.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p 270-289, February, 1983. 12 Fig, 3 Tab, 29 Ref.

Descriptors: *Velocity distribution, *Smooth rectangular open channels, *Open channels, Hydrodynamics, Flow characteristics, Model studies, Formulation of velocity model, Turbulent flow.

The theoretical investigations of Prandtl and Von Karman on flow through pipes, and the experimental studies of Nikuradse have led to rational formulas for velocity distribution and hydraulic resistance for turbulent flows over flat plates and in circular pipes. Velocity distribution in a smooth rectangular channel is studied by dividing the channel into four regions. Region 1 comprises the inner region of the bed and the outer region of the side wall. Region 2 belongs to the inner regions of both the bed and the side wall. Region 3 consists of the inner region of the side wall and the outer region of the bed. Region 4 forms the outer regions of both the bed and the side wall. The aspect ratio is varied from 2.0 to 8.0 and the Froude number from 0.2 to 0.7. Experiments included the aspect ratio of 1.0 also for Froude numbers of 0.2 and 0.3. The range of Reynolds number defined in terms of the hydraulic radius and the cross sectional mean velocity lies between 100,000 and 700,000. (Murphy-IVI)
W84-04831

HYDRAULICS OF STRUCTURES FOR CROSSING RIVER VALLEYS (HYDRAULIQUE DES OUVRAGES DE FRANCHISSEMENT DES VALLEES FLUVIALES),

Electricite de France, Chatou. Direction des Etudes et Recherches.
G. Nicollet.
La Houille Blanche, Vol. 4, p 289-308, 1982. 36 Fig, 1 Tab, 32 Ref.

Descriptors: *Hydraulic engineering, *Hydraulic design, *Bridges, Hydrodynamics, Hydraulic properties, Big Sioux River, Logone River, Rhone River, Hydraulic similitude, Performance evaluation, Hydraulic structures.

Problems associated with hydraulic aspects for structures across waterways and the definition of the broad lines of a projected structure across waterways is presented. The study offers practical solutions for determining the maximum raising point of the upstream water tract due to narrowing and the risks of non-stable flow, establishing predictions of errosion of underminable beds, general trend of the riverbed, local erosion due to the abutments and piers, and means of protection. Examples using the bridges of Pouzin over the Rhone River, Moundou over the Logone and a bridge over the Big Sioux River are presented. (Murphy-IVI)
W84-04946

SURVEILLANCE AND REINFORCEMENT OF FOUNDATIONS FOR STRUCTURE IN AQUATIC SITES THE HYDRAULIC ASPECT (SURVEILLANCE ET CONFORTEMENT DES FOUNDATIONS D'OUVRAGES D'ART EN SITE AQUATIQUE ASPECT HYDRAULIQUE),
Laboratoire National d'Hydraulique, Chatou (France).
M. Ramette.
La Houille Blanche, Vol. 1, p 41-48, 1982. 22 Fig.

Descriptors: *Hydrodynamics, *Hydraulic properties, *Flow around objects, *Flow characteristics, Design criteria, Hydraulic structures, Obstruction to flow.

Natural occurring phenomena in a river are described along with the effects structures (bridges, dykes, sills, etc.) have on this phenomena. A new state of equilibrium of the river is then defined. The possible aggressive phenomena, which was unpredicted during the design stage, that may compromise the stability of the structure was reviewed in an attempt to define the general principles for the appropriate countermeasures. (Murphy-IVI)
W84-04950

COMPARISON OF MANUAL WAVE PREDICTION MODELS,
National Water Research Inst., Burlington (Ontario). Shore Processes Section.
C. T. Bishop.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 109, No. 1, p 1-17, February, 1983. 6 Fig, 3 Tab, 16 Ref.

Descriptors: *Fetch, *Waves, *Lake Ontario, Wind, Mathematical models, Donelan model, JONSWAP model, SMB model, Wave models, Prediction.

The predictions of three wave models have been compared with fetch limited, pseudo steady-state wave data measured at two locations on Lake Ontario in 1972. The accuracies of the Donelan, JONSWAP, and SMB models seem to be comparable, with standard errors of about 0.8 ft (0.25 m) in predicting characteristic wave heights and about 0.6 s in predicting the periods at the peak of the wave energy spectra. The accuracy of the Donelan model is somewhat better than that of the other two models. Moreover, the Donelan model provides an estimate of the peak wave energy direction rather than simply assuming coincident wind and wave directions. Therefore, this model should prove particularly useful for engineering application in steady fetch-limited conditions. (Baker-IVI)
W84-04959

DESIGN OF INLAND NAVIGATION FAIRWAYS,
Waterloopkundig Lab., Delft (Netherlands). Rivers and Navigation Branch.
H. G. Blaauw, and H. J. Verhey.
Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 109, No. 1, p 18-30, February, 1983. 6 Fig, 13 Ref.

Descriptors: *Navigation canals, *Canal design, *Fairways, Design criteria, Economic aspects, Cost-benefit analysis, Bank protection, Model studies, Environmental effects.

A comprehensive systematic approach for the design of inland navigation fairways distinguishes three main phases: economic studies, initial design phase, and final design phase. Each of the phases is characterized by different research tools to be applied. The method itself has an iterative character in which cost-benefit analysis and or ranking matrices, or both, play an important role. An intense cooperation between specialists of various disciplines is necessary. Before starting the design process design requirements have to be formulated and each design phase requires its own research tools to be applied. At the end of each phase the generated alternatives are screened leading to one or more selected alternatives on the basis of cost-benefit analyses and ranking matrices or both; at the end of both initial and final design as well as the impact assessment study the results obtained are fed back to the modal split to check if the design requirements are still met. The design is not completed without paying thorough attention to fairway equipment and authority. The width of the fairway is taken into consideration in the iteration process. The costs of construction of bank protection decrease when the fairway width increases. The total costs of fairway dredging and construction bank protections can therefore be minimized. (Baker-IVI)
W84-04960

STATISTICAL STUDY OF PARTIAL FLOW CHARACTERISTICS OF CENTRIFUGAL PUMPS AND OF APPROXIMATE DETERMINATION OF THE CRITICAL FLOW (ETUDE STATISTIQUE SUR LES CARACTERISTIQUES A DEBIT PARTIEL DES POMPES CENTRIFUGES ET SUR LA DETERMINATION APPROXIMATIVE DU DEBIT CRITIQUE),
Ecole Nationale Superieure des Arts et Metiers, Paris (France).
R. Rey, P. Guiton, Y. Kermarec, and G. Vullioud.
La Houille Blanche, Vol. 2/3, p 107-120, 1982. 11 Fig.

Descriptors: *Pumps, *Centrifugal pumps, *Critical flow, Statistical studies, Partial flow.

Six pump manufacturers gathered as a sub-working group of the SHF helped to draw up statistics on the H(Q) and P(Q) characteristics of over 60 different partial flow centrifugal pumps. This has made it possible to go beyond individual habits and traditions, while preserving anonymity. The study has pointed up general trends and areas of convergence of points portraying pumps with satisfactory H(Q) characteristics, which can only be departed from with extreme caution. As partial flow operation is associated with the more-or-less sudden appearance of critical flow, it was logical to extend the statistical study to the various relative values of this critical flow. This has been the authors' aim, while proposing an approximate method based on the interpretation of graphs representing P(Q) characteristics. (Author's abstract)
W84-05024

HYDRAULIC INVESTIGATION OF A PROPOSED DIVERSION OF THE RIVER CLYDE,
University of Strathclyde, Glasgow (Scotland). Dept. of Civil Engineering.
J. F. Riddell, and J. Ellis.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 1, p 28-40, February, 1983. 7 Fig, 3 Tab, 2 Ref.

Descriptors: *River Clyde, *Hydraulic design, *Diversions, *Highways, Channels, Construction, Diversion channels, Model studies, Planning, Flood control, Culverts, Environmental effects.

The range of possible options available to satisfy economic, hydraulic, and environmental constraints affecting the proposal for the Hamilton Road Route to make a double crossing of a meander of the River Clyde was considered. A numerical model study was undertaken to examine the feasibility of the option chosen. The arrangement of restricted flow culverts at the road crossings together with a diversion channel which would come into use only during times of flood was found to provide a solution which resulted in no increase in the probability of upstream flooding, and the maintenance of environmentally acceptable conditions at times of low flow. The hydraulic constraints of maintaining some flow in the by-passed channel and causing an increase in upstream water levels produced a complicated problem of analysis which was tackled by means of a numerical model. After calibration from existing flow and level data, the model allowed a rapid assessment of the effects of varying the geometry of both the diversion channel and the culverts. It is possible to provide a diversion channel/culvert configuration which will maintain low flows, and an element of flood flushing, in the existing channel while not causing any increase in upstream water levels during times of flood. The diversion option was hydrologically feasible, but it was later decided that the cost advantages were not as significant as first thought. The decision has been made to construct two conventional bridges at Cuningar, with the numerical model now being employed to study the effect on water levels of different arrangements of bridge piers and temporary works. (Baker-IVI)
W84-05050

FLOODFLOW FORECASTING DURING DAM CONSTUCTION,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
M. Mimikou.
International Water Power and Dam Construction, Vol. 36, No. 5, p 15-17, May, 1984. 2 Fig, 4 Tab, 6 Ref.

Descriptors: *Flood forecasting, *Dam construction, *Pournari Dam, *Greece, Construction, Dams, Flood control, Prediction.

A short-term real time floodflow forecasting method is presented for the Pournari dam site in Greece during the construction of the diversion works. The floodflows are accurately forecast at a flow measuring station in the neighborhood of the dam site by the use of water level and rainfall information from key stations located upstream. The time of the flood arrival is also estimated. The method is simple to use and accurate. It does not need a computer and gives sufficiently long forecasting times for adequate preparation at the site. It can be applied cheaply and successfully to short term floodflow forecasting in real time. (Baker-IVI)
W84-05097

TWO-D FLOW WITH SEDIMENT BY CHARACTERISTICS METHOD,
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 2A.
W84-05148

CONTROL OF WATER HAMMER IN WATER SUPPLY SYSTEMS (BEHERRSCHUNG VON DRUCKSTOBEN BEI WASSERVERSORGUNGSSYSTEMEN),
Sulzer Bros. Ltd., Winterthur (Switzerland).
H. Waller.
Wasserwirtschaft, Vol. 73, No. 4, p 113-119, April, 1983. 10 Fig, 2 Tab, 14 Ref.

Descriptors: *Water hammer, *Water conveyance, Flow characteristics, Hydraulic machinery, Pumps, Pump speed, Hydraulic valves, Drive mechanisms, Computer programs.

Water hammer investigations are particularly important for the water supply systems of complicated installations. This article considers the instationary flow conditions that occur during start-up,

shutdown and changeover of the pump, change of valve position and pump speed, or when the drive mechanism fails. Systems that operate with high velocity and low pressure are particularly endangered. Unacceptable underpressure should also be avoided to ensure that the column of water remains intact. Installations constituting a danger risk are equipped with flywheels and expansion chambers. These safety elements can be determined approximately or with the aid of a computer program. The article concludes with a calculation example. (Murphy-IVI)
W84-05238

HYDRAULIC AND OPERATIONAL ASPECTS FOR THE ENERGY RECOVERY CONCEPT APPLIED AT THE WATER RESERVOIR SCHONBUHL OF THE LANDESWASSERVERSORGUNG STUTTGART (HYDRAULISCHE UND BETRIEBLICHE ASPEKTE DER ENERGIERUCKGEWINNUNGS - ANLAGE SCHONBUHL DES ZWECKVERBANDES LANDESWASSERVERSORGUNG),
Zweckverband Landeswasserversorgung, Stuttgart (Germany, F.R.).
D. Flinspach, J. Giesecke, and H.-B. Horlacher.
Wasserwirtschaft, Vol. 73, No. 7/8, p 226-230, 1983. 6 Fig, 1 Tab, 5 Ref.

Descriptors: *Energy recovery, *Schonbuhl reservoir, *West Germany, Francis turbines, Hydroelectric power, Pipelines, Head, Hydrodynamics, Transient flow, Water hammer.

In connection with the new large water reservoir Schonbuhl built by the water supply authority 'Zweckverband Landeswasserversorgung', a fourth energy recovery facility was integrated in the existing system composed of three long distance pipelines. A Francis turbine of 955 kW capacity, drawing off 55 m head between both Thomashardt and Schonbuhl reservoirs, is used for this purpose. This concept of energy recovery allows a return of about 20% of pumping energy; the latter being used subsequently for the operation of the above-mentioned long distance pipelines. The hydrodynamic effects of transient flow resulting from turbine operation have been determined by measurements and detailed waterhammer calculation. (Author's abstract)
W84-05247

8C. Hydraulic Machinery

INTEGRATED DEVELOPMENT OF A LARGE RIVER: THE RHONE; B. DEVELOPMENT OF ELECTRO-MECHANICAL EQUIPMENTS (L'AMENAGEMENT INTEGRE D'UN GRAND FLEUVE: LE RHONE; B. EVOLUTION DES EQUIPEMENTS ELECTROMECANIQUES),
Compagnie Nationale du Rhone, Lyon (France).
P. Cazenave.
La Houille Blanche, Vol. 5/6, p 427-432, 1982. 6 Ref.

Descriptors: *Rhone River, *France, *Water resources development, Valves, Gates, Dams, Turbines, Automation, Locks, Hydroelectric plants, Electrical equipment, Mechanical equipment.

It took half a century to develop the Rhone River between Genissiat and Loyettes, France. Low heads have been harnessed. The development had to comply with operating constraints related to energy generation and navigation, and allow for substantial variation in flows and head. Technological improvements and operating experience have led to major changes in the following; flow and head; safety valves; discharge facilities; bulb generating sets; automation; locks; and dams. The large locks (12 x 195 m) on the Rhone have led to the development to increasingly reliable units, necessitated by the fact that each lock is in permanent service. Twenty-one main dams have been built, including 20 mobile dams on the rivers. Major progress has been made in construction, especially gate construction. (Moore-IVI)
W84-05020

DESIGN AND CONSTRUCTION OF LARGE TURBINES. THE FRANCIS TURBINES OF THE TUCURUI STATION (BRAZIL) (CONCEPTION ET CONSTRUCTION DES TURBOMACHINES DE GRANDES DIMENSIONS, LES TURBINES FRANCIS DE LA CENTRALE DE TUCURUI (BRESIL),
Neyrpic, Grenoble (France). Bureau d'Etudes Turbines.
A. Sauron, and G. Caillot.
La Houille Blanche, Vol. 5/6, p 473-486, 1982. 3 Fig, 1 Tab.

Descriptors: *Turbines, *Tucurui Hydroelectric Station, *Brazil, Francis turbines, Design, Construction, Hydraulic design, Computers.

Increasing the unit power of hydroelectric turbines while improving the use ratios of sets is governed by the need to make developments profitable. The problems met and their solutions regarding design, calculation and the construction of large turbines have been reviewed using the example of the Tucurui turbines currently being assembled. The Tucurui hydroelectric project is located on the river Tocantin in the northern part of Brazil, about 300 km from Belem. Topics discussed include: hydraulic design; mechanical design; study and construction of the main parts; and load support bearing exceeding 2000 tons. New prospects have been opened up by the use of computer aided design and the development of manufacturing facilities. (Moore-IVI)
W84-05022

UNCERTAINTIES TO BE TAKEN INTO ACCOUNT ON H(Q) AND P(Q) CURVES OF PARTIAL FLOW PUMPS AND PUMP TURBINES (INCERTITUDES A PRENDRE EN COMPTE SUR LES COURBES H(Q) ET P(Q) A DEBIT PARTIEL DES POMPES ET DE POMPES-TURBINES),
Societe Franco-Americaine de Constructions Atomiques, Courbevoie (France).
J. P. Clement, J. M. Deplanque, H. Quesnon, J. F. Lapray, and R. Philibert.
La Houille Blanche, Vol. 2/3, p 121-130, 1982. 10 Fig, 1 Ref.

Descriptors: *Pump turbines, *Partial flow pumps, Hydraulic equipment, Pumps, Model studies, Nuclear powerplants.

The manufacturers and users of pumps and some pump turbines are increasingly confronted with the problem of drawing up characteristic curves respecting contractual values which can range from no flow to overflow and often allow partial flow operation to be performed satisfactorily. In practice: on the one hand, there are differences between forecast curves drawn up on the basis of tests using a scale model and the curves recorded on an industrial machine; on the other hand, there are often large differences between the characteristic curves of machines which are known to be identical. The paper attempts to illustrate the importance and origin of these differences and their physical effects on the respect of requirements. The uncertainties due to the transposition of curves of the model and the influence of small geometrical differences in construction are underlined. It also attempts to ascertain the reasons underlying operating requirements and constraints recorded on the characteristics curves of pumps used in PWR nuclear power stations. (Author's abstract)
W84-05025

INFLUENCE OF THE DOWNSTREAM GEOMETRICAL LAYOUT OF THE IMPELLER ON THE CHARACTERISTICS OF PARTIAL FLOW PUMPS (INFLUENCE DE LA GEOMETRIE DE L'ENVIRONNEMENT AVAL DE LA ROUE SUR LES CARACTERISTIQUES DES POMPES A DEBIT PARTIEL),
Ecole Nationale Superieure des Arts et Metiers, Lille (France). Lab. de Mecanique.
G. Caignaert.
La Houille Blanche, Vol. 2/3, p 131-138, 1982. 13 Fig, 19 Ref.

Descriptors: *Centrifugal pumps, *Impellers, Geometry, Partial flow pumps, Vaned diffusors, Volutes, Pumps.

Geometrical parameters of vaned diffusors and volutes influence partial flow characteristics of centrifugal pumps. Modifications of the casing downstream of the impeller concern many geometrical parametes, and it is not easy to characterize the results: only trends emerge. These trends vary according to the type of pump (specific speed influence) and to the impeller geometry; a general trend seems to be much more difficult to obtain for pumps operating at low specific speed. Some changes made in the volute have an influence on the partial flow characteristics of single-volute pumps. The volute tongue appears to be most important, especially the relative radial gap and the tongue radius: Head coefficients increase and power coefficients tend to decrease when these parameters increase. The case of vaned diffuser pumps is then examined. Modification of vaned-diffusor inlets, including the relative radial gap, the blade inlet radius, the blade inlet angle, the diffusor throat area, the diffusor's axial position in relation to the impeller and gaps between impeller and casing were also investigated. (Moore-IVI)
W84-05026

CRITICAL FLOW ENGENDERING APPEARANCE OF RECIRCULATION AT CENTRIFUGAL PUMP IMPELLER INLET: DETERMINANT PHENOMENA, DETECTION METHODS, FORECASTING CRITERIA (DEBIT CRITIQUE D'APPARITION DE LA RECIRCULATION A L'ENTREE DES ROUES DE POMPES CENTRIFUGES: PHENOMENES DETERMINANTS, METHODES DE DETECTION, CRITERES DE PREVISION),
Worthington S.p.A, Milan (Italy).
B. Schiavello.
La Houille Blanche, Vol. 2/3, p 139-158, 1982. 13 Fig, 2 Tab, 24 Ref.

Descriptors: *Centrifugal pumps, *Critical flow, Model studies, Recirculation, Impellers, Volutes, Pumps.

The relationship between the 'peak' of the curve at the beginning of cavitation and the critical flow producing the appearance of recirculation and prerotation at impeller inlet is studied. A physical analysis of the phenomenon of the boundary layer separation on the blade section side in the centrifugal pump impeller shows that there is no direct influence of centrifugal forces, a limited direct influence of the Coriolis forces, a critical influence of the aerodynamic forces, and an important influence of the tridimensional and viscous phenomena. The impeller design appeared more crucial than the volute design. The detection of the critical capacity is important in order to determine the reliable operating range of a pump. Direct methods for testing critical capacity are more suitable for research on models because they are accurate and complete, but also time consuming. The indirect methods show an acceptable scattering. The adoption of several indirect methods reduces the degree of uncertainty and seems to be a reliable procedure for field detection of the critical capacity of full scale pumps. Advance calculation of critical flow using simple mono-dimensional models, adjusted using different factors portraying tri-dimensional effects and losses, requires a careful forecast of the relative flow at impeller outlet in partial flow operating conditions. (Moore-IVI)
W84-05027

OPERATION IN PARALLEL OF PUMPS WITH HUNCHBACK CURVATURE (FONCTIONNEMENT EN PARALLELE DE POMPES A COURBES BOSSUES),
Conservatoire National des Arts et Metiers, Paris (France).
M. Sedille, M. Frelin, and M. Pluviose.
La Houille Blanche, Vol. 2/3, p 159-166, 1982. 13 Fig.

Descriptors: *Pumps, *Parallel operation, Pump inlets, Model studies, Mathematical models, Hydraulic models.

Parallel operation of pumps with 'hunchback curvature' leads to either stable or unstable operating conditions, depending on the system they supply and its inlet variations. Stable operating conditions are obtained when the two pumps operate in the stable part of their characteristics, and in certain cases when one operates in the stable part and the other in reverse flow. Their study requires modeling the system as a whole, and writing equations of movement which take inertia and capacity into account. The study of a special case which arose (pumps with slightly different characteristics) has shown that the schematic approach followed was inadequate and that the inertia conditions of all sections, including pump sections, had to be taken into account to portray observed phenomena. When pressure values are low, the capacity of pipes can be neglected, considering only mass movements. Beyond that, wave propagations would have to be taken into account. (Moore-IVI)
W84-05028

HYDRODYNAMIC VISUALIZATION OF FLOW USING A SCALE-MODEL OF AN AXIAL FLOW TURBOMACHINE (VISUALISATION HYDRODYNAMIQUE DE L'ECOULEMENT DANS UNE MAQUETTE DE TURBOMACHINE AXIALE),
Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux (France).
H. Werle.
La Houille Blanche, Vol. 2/3, p 175-184, 1982. 7 Fig, 14 Ref.

Descriptors: *Model studies, *Turbines, *Hydrodynamics, Hydraulic models, Simulation, Rotating stall, Eddies.

The physical study of non-stationary flow in a scale-model fitted with an isolated mobile runner or in the presence of a rectifer was performed through visual examination carried out in a vertical hydraulic vessel. The runner is fitted with 20 cylindrical vanes (circumference = 50 mm) and is placed in a cylindrical channel (radius of casing = 146 mm). As the flow velocity and the speed of rotation of the runner are controlled and regulated independently, all operating conditions can be simulated. Terminal stage flow is highly sensitive to the load variations necessitated by its environment. A separated flow rotation en bloc with the mobile blades occurs at the downstream section of the blade when the volume flow is reduced to 25% below its rated value. The stall then increases and forces the flow to the central part and the periphery up to the point at which a second toric vortex is formed upstream and at the tip of the blade. This eddy rotates at virtually the same speed as the mobile blades. At zero flow, the two eddies rotating in opposite directions invade the channel and produce losses due to ventilation, in which the centrifugal effect is dominant. (Moore-IVI)
W84-05030

ANALYSIS OF INDUSTRIAL TESTING OF TURBINE PUMPS OUTSIDE NORMAL AND DURING TRANSIENT OPERATING CONDITIONS (ANALYSE DES ESSAIS INDUSTRIELS DES TURBINES-POMPES HORS DES ZONES DE FONCTIONNEMENT NORMAL ET LORS DES TRANSITOIRES),
Neyrpic, Grenoble (France).
S. Casacci, and P. Jarriand.
La Houille Blanche, Vol. 2/3, p 185-196, 1982. 17 Fig.

Descriptors: *Pump turbines, *Transient operating conditions, Turbines, Rotation, Wear, Stress, Start-up, Shutdown, Model studies, Hydraulic models.

When the Cheylas station, equipped with two 250 MW turbine pumps under 250 m head, was put in service, a very large testing program was undertaken to analyse the behavior of these machines in main normal transient operating conditions. The operation of turbine pumps requires daily start ups and shutdowns, with or without a change in the direction of rotation. Their frequent operation outside the range of optimum use should not engender abnormal wear of equipment. It is thus important to know the stresses to which these reversible machines are subjected during transient operating conditions, including turbine or pump trip when the gate operating mechanism is blocked in the open position. The present paper analyses the results of tests performed on pump start up, turbine and pump trip with the gate operating mechanism open, on-load cuts and operating in compensator mode. The comparison of the results of industrial tests with those obtained on scale-models shows that the stresses applied to the main parts of the machine can be estimated with an adequate degree of accuracy. This finding allows the components of these machines to be manufactured to a size guaranteeing operating conditions over time similar to those of the best conventional turbines. (Author's abstract)
W84-05031

INFLUENCE OF CAVITATION ON AVERAGE AND INSTANTANEOUS CHARACTERISTICS OF TURBINES AND PUMP TURBINES (INFLUENCE DE LA CAVITATION SUR LES CARACTERISTIQUES MOYENNES ET INSTANTANEES DES TURBINES ET DES POMPES-TURBINES),
Hydroart S.p.A., Milan (Italy).
G. Borciani.
La Houille Blanche, Vol. 2/3, p 197-208, 1982. 11 Fig, 8 Ref.

Descriptors: *Cavitation, *Francis turbines, *Pump turbines, *Turbines, Runaway speed, Model studies, Hydraulic models.

The influence of cavitation on the average characteristics of a Francis turbine or Francis-type pump turbine is studied for abnormal operating conditions, in the following areas: instability area during operation as a pump; zero flow pump mode; area of reduced flow as a turbine; runaway speed; turbine-brake; and reverse pump quadrant. Based on laboratory measurements on a model, the critical sigma values found in the five areas mentioned are higher than those of standard sigma values for the areas of the machine under normal operating conditions. Particular importance is place on two observed cases of hydraulic instability: a pump-turbine operating as a partial flow pump, and a turbine of average specific speed. Instability is a function of the cavitation coefficient which determines the shift form one hydraulic behavior to another at the runner outlet. The influence of cavitation on the instantaneous characteristics is examined in a turbine at full load, at a low rate of flow and at runaway speed. The decrease in cavitation coefficient causes an increase of the fluctuations both at partial flow and at runaway seed for some of the magnitudes examined. When designing a hydraulic machine, the laboratory tests on the model should be extended to a wide range of sigma values covering the values projected for the prototype. (Moore-IVI)
W84-05032

EXPERIMENTAL ANALYSIS OF THE HYDRAULIC STABILITY OF THE PARTIAL LOAD FRANCIS TURBINE (ANALYSE EXPERIMENTALE DE LA STABILITE HYDRAULIQUE DE LA TURBINE FRANCIS A CHARGE PARTIELLE),
Ecole Polytechnique Federale de Lausanne (Switzerland).
P. Henry, M. Wegner, and J. E. Graeser.
La Houille Blanche, Vol. 2/3, p 209-218, 1982. 11 Fig, 21 Ref.

Descriptors: *Frances turbines, *Hydraulic stability, Turbines, Model studies, Hydraulic models, Torque, Pressure fluctuations, Cavitation, Head.

An attempt is made to clarify the relationships between hydraulic stability and pressure fluctuations, based upon the knowledge that this stability is expressed in terms of the fluctuation of the motor torque of the turbine shaft. The role of the different frequencies produced by the flow is studied in particular. Frequencies, amplitudes and phases measured on the scale-model are systematically analysed. Two main parameters govern these model tests: the degree of cavitation with a constant operating head; and the operating head keeping constant either the cavitation number or the dimension of the cavitating dead water core. At the dominant frequency, pressure fluctuations in the draft tube can increase without magnifying torque fluctuation or pressure fluctuation in the volute in the same proportion. By contrast, when there is a marked increase of the amplitude at the first harmonic of the pressure fluctuation in the draft tube, the motor torque fluctuations follow a similar behavior. The head has no relevant effect, especially the lowest, which does not induce a lower value of relative fluctuations. Observed dimensions of the cavitating dead water core are not sufficiently developed to draw a firm conclusion as to the effect of the operating head. (Moore-IVI)
W84-05033

CHARACTERISTICS OF AXIAL THRUST (CARACTERISTIQUES DES POUSSEES AXIALES),
Ecole Polytechnique Federale de Lausanne (Switzerland).
P. Henry, V. Zanetti, and M. Wegner.
La Houille Blanche, Vol. 2/3, p 227-236, 1982. 15 Fig.

Descriptors: *Axial thrust, *Hydraulic machinery, Turbines, Pump turbines, Francis turbines, Load, Specific speed, Mathematical studies.

It is important to have specific knowledge of axial thrust in hydraulic machinery, especially for large turbines and pump turbines, for the purpose of calculating thrusts. Internal forces are induced by both pressure and momentum effects. Nondimensional parameters corresponding to the internal and external components are calculated and plotted against specific speed for the optimum operating range. The theoretical forecast of thrust is not too difficult in the neighborhood or optimum efficiency of machines. An example is given of the relationship between static pressures, discharge and axial thrust for a turbine rotating at average specific speed. High specific speeds are more sensitive to flow variations than low specific speeds. The calculation of internal thrust illustrated by a standardized Francis turbine runner channel. External thrust is then measured for a simplified runner layout. As one moves away from optimum efficiency, the calculation becomes more difficult. Measurements using a scale-method alone provide results which must be used with great caution because of the problems of similarity. These problems become particularly acute when the specific speed decreases. The calculation of axial thrust at optimum load may be considered safe, but the same calculation in the partial load range remains inaccurate due to three-dimensional and non-stationary effects. (Moore-IVI)
W84-05034

RADIAL THRUST IN HYDRAULIC MACHINES: LABORATORY TESTING (LA POUSSEE RADIALE DANS LES MACHINES HYDRAULIQUES: EXPERIENCES DE LABORATOIRE),
Hydroart S.p.A., Milan (Italy).
V. Zanetti.
La Houille Blanche, Vol. 2/3, p 237-246, 1982. 15 Fig.

Descriptors: *Hydraulic machinery, *Radial thrust, *Francis turbines, Turbines, Thrust, Runaway, Hydroelectric plants, Rope frequency, Specific speed, Pump turbines.

The radial thrust exerted by the flow on the runner plays an important role among the loads acting on a hydraulic machine at the different operating conditions. The fixed thrust is due to dyssymmetries in the stationary parts. It has the effect of bending the shaft line and loading the guide bearings. A second type of thrust is the dynamic thrust which causes vibrations and has more importance in machine design, especially for machines for hydroelectric plants. The thrust rotating at the rope frequency,

characteristic of the operation of a Francis turbine at a partial load or runaway conditions, may cause sliding of the rotating part on the stationary part at the labyrinths. This must be taken into account when calculating fatigue strength. Radial thrust rotating at the rope frequency is directly associated with the pressure pulse below the runner and increases with the specific speed of the unit. A similar phenomenon occurs in runaway operation: the thrust attains its maximum value in high specific speed Francis turbines. Random thrust occurs at different operating conditions; in pump turbines reaching its peak values at runaway, in the braking mode and in the pump mode at strongly reduced flows. (Moore-VI)
W84-05035

VIBRATIONS OF GUIDE VANES OF TURBOMACHINERY IN RUNAWAY OPERATION (VIBRATIONS DES DIRECTRICES DES TURBOMACHINES A L'EMBALLEMENT),
Neyrpic, Grenoble (France).
P. Boussuges, H. Amblard, and C. Lathuile.
La Houille Blanche, Vol. 2/3, p 247-256, 1982. 10 Fig.

Descriptors: *Guide vanes, *Turbines, *Runaway, *Vibration, Hydraulic machinery, Model studies, Pressure pulses, Specific speed, Torque.

Stresses suffered by the mobile guide vanes of turbomachinery under runaway conditions are investigated, based on scale-model and industrial machine testing. After analyzing pressure pulses in the air-gap between the runner and the distributor, induced by the runner, for machines operating at different specific speeds, torque fluctuation values relating to guide vanes are examined. An attempt is made to draw up a general law providing an order of magnitude for these values. An attempt is also made to give a finer analysis of the findings to identify the parameters influencing the pheomenon: the shape of guide vanes, the air-gap between the runner and the distributor, and the geometry of the runner. While it has been possible to identify the air-gap, the influence of the various parameters associated with the runner is too complex to allow specific laws to be stipulated presently. A synthesis of approximate overall laws is presented. (Author's abstract)
W84-05036

QUASI THREE-DIMENSIONAL FLOWS IN HYDRAULIC TURBOMACHINES (MODELISATION QUASI-TRIDIMENSIONNELLE DES ECOULEMENTS DANS LES TURBOMACHINES HYDRAULIQUES),
Neyrpic, Grenoble (France).
L. R. Eremeef, and R. Philibert.
La Houille Blanche, Vol. 7/8, p 543-552, 1982. 8 Fig, 9 Ref.

Descriptors: Mathematical models, *Hydraulic machinery, *Turbines, Rotors, Meridional flow, Blade-to-blade flow, Flow.

The three-dimensional flow of a perfect, incompressible fluid through the rotor of a turbomachine is studied with a method using two-dimensional flows: meridional flow, and blade-to-blade flow. The mathematical model used exploits the theory of quasi-three-dimensional flows known under the name of the S1-S2 surfaces model. The method consists of coupling a calculation of meridian flow with a 'blade-to-blade' calculation until the solutions come together. The two flow programs use to advantage the same types of algorithm, which permit transformation of the nonlinear Poisson-type equations into integral Fredholm equations of the second kind. Good results are obtained with this flow model. (Moore-IVI)
W84-05037

THEORETICAL-EXPERIMENTAL ANALYSIS OF REAL FLOWS IN ASSORADIAL PUMPS (ANALYSE THEORIQUE-EXPERIMENTALE DE L'ECOULEMENT REEL DANS LES POMPES ASSORADIALES),
Florence Univ. (Italy). Ist. di Energetica.
E. Carnevale, S. Giusti, and G. Angelo.
La Houille Blanche, Vol. 7/8, p 553-557, 1982. 8 Fig, 3 Ref.

Descriptors: *Mathematical models, *Pumps, *Flow, Centrifugal pumps, Mixed-flow pumps, Impellers, Entropy, Blades, Runners.

A numerical model is developed for non-isoentropic through-flow calculation in centrifugal and mixed-flow pump impellers. The calculation is developed on an S2 type surface (using WU's theory) in the presence of a field of frictional forces. The flow is assumed to take place in the presence of a dissipative force field locally opposite to the relative velocity vector and tangent to the stream line. Combining the basic equations of continuity, entropy production, energy and motion, defining the local geometry of the stream surface S2 and the stream function psi, it is possible to derive a final flow equation. The stream surface equation is obtained starting form the blade geometry and considering its distortion due to the slip effect. In the final flow equation, an entropy gradient appears that can be correlated with the values for total pressure at the runner input and output. The numerical model is applied to analysis of the flow in an assoradial runner for three different operating conditions; the design conditions and two off-design working points. (Moore-IVI)
W84-05038

MODEL OF THE FLOW IN FRONTOSPIRAL CASING (MODELE D'ECOULEMENT DANS LES BACHES FRONTO-SPIRALES),
Neyrpic, Grenoble (France).
J. Corniglion, P. Vinh, and M. Couston.
La Houille Blanche, Vol. 7/8, p 571-578, 1982. 9 Fig, 6 Ref.

Descriptors: *Hydraulic design, *Kaplan turbines, Hydraulic models, Flow, Turbines, Hydraulic machinery, Turbulence, Blades.

The problem of the hydraulic design of the feed tank for a low-head Kaplan turbine has been solved by making numerous modifications to the layouts after experimental trials. The object of this study is to design a theoretical model of the flow that will permit a proper supply to the turbomachine while keeping velocities and flow rates homogeneous in the peripheral sense in order to obtain maximum efficiency for the installation. The present approach makes it possible to design the tank, fitted with guide vanes, in a way that will provide this condition of homogeneity. The procedure is to solve a quasi-three-dimensional field problem by a semi-inverse method from calculation of the distribution of the associated turbulence that each guide blade must generate; the blade shape is deduced from this distribution. Numerical results applied to an industrial configuration are presented. (Author's abstract)
W84-05039

FLOW FIELD ANALYSIS IN A KAPLAN TURBINE: COMPARISON BETWEEN THEORETICAL CALCULATIONS, VELOCITY MEASUREMENTS AND CAVITATION OBSERVATIONS (ECOULEMENT DANS UNE TURBINE KAPLAN: COMPARAISON ENTRE CALCUL THEORIQUE, MESURES DE VITESSE ET OBSERVATIONS DE CAVITATION),
Hydroart S.p.A., Milan (Italy).
O. Ceravola, M. Ubaldi, P. Zunino, and A. Satta.
La Houille Blanche, Vol. 7/8, p 579-587, 1982. 12 Fig, 7 Ref.

Descriptors: *Kaplan turbines, *Cavitation, *Flow field, Flow velocity, Computers, Mathematical equations, Blades, Runners.

Experimental and theoretical results of the flow field analysis in a medium specific speed Kaplan turbine model are presented. The experimental analysis consists of velocity and total pressure measurements taken with bidirectional probes in three sections upstream and one downstream of the runner, and observation and photos of the cavitation zones on the blade surfaces and in the blade channels for different values of the the cavitaiton coefficient. The quasi-three dimensional analysis of the flow field was carried out using a computer program based on the method of fixed projection lines. A program based on the method of integral equations was used for the blade-to-blade calculation. An exact prediction of the extension of the cavitating regions cannot be obtained because the method does not take into account the effect of the vapor bubbles on the pressure distribution, but the calculations generally are in good agreement with the cavitation configurations. (Moore-IVI)
W84-05040

EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE BEHAVIOUR OF A REVERSIBLE PUMP-TURBINE RUNNER AT AND OFF DESIGN CONDITIONS (RECHERCHE EXPERIMENTALE ET NUMERIQUE SUR LE COMPORTEMENT D'UNE ROUE REVERSIBLE AU POINT DE TRACE ET HORS DU POINT DE TRACE),
Padua Univ. (Italy).
G. Ventrone, A. Mirandola, and G. Navarro.
La Houille Blanche, Vol. 7/8, p 607-613, 1982. 11 Fig, 7 Ref.

Descriptors: *Pump turbines, *Hydraulic machinery, *Turbines, Model studies, Mathematical equations, Runners, Vanes, Impellers, Flow velocity.

The behavior in pumping mode of a reversible runner was analysed with and without diffusion vanes. The runner tip clearance has been traversed in pump operation in order to examine the distortion of the flow induced by the stationary system. The average values of flow angle, velocity, and total pressure agree with theoretical estimates only at the matching point of runner and diffuser. At lower or higher rates the average value of the meridional component of the absolute velocity differed considerable from actual through-flow. The runner input head obtained from the averaged values of the tangental component of the velocity, which was expected to be greater than the total head rise through the runner, appeared to be smaller than the latter at flows below the design rate and greater at higher flows. The discrepancies may be due to the interaction of runner and stationary vanes, which distort the flowlines in the clearance annulus. The stationary vanes were removed from the diffuser channel so as to obtain an unobstructed annulus where free flow conditions would be set up, comparable to those existing outside an isolated runner. Flow measurement showed better consistency with theoretical estimates. The ratio of slip velocity to runner tangential velocity did not change appreciably with the rate of flow. Known numerical solutions of the equation of motion may yield satisfactory results provided no external action is exeerted on the runner flow other than the pressure forces exchanged by the runner itself. For pump runners with volute or vaned diffuser casings, the boundary conditions at the impeller exit should be defined by an equation expressing the distorting effects of the stationary system on the flow. (Moore-IVI)
W84-05041

DIPHASIC FLOW DOWNSTREAM OF CIRCULATION-WATER CONDENSER DURING PRIMING (ECOULEMENT DIPHASIQUE A L'AVAL D'UN CONDENSEUR DE CIRCUIT DE CIRCULATION EN COURS D'AMORCAGE),
B. Ibler, M. Sabaton, and R. Canavelis.
La Houille Blanche, Vol. 7/8, p 623-632, 1982. 15 fig, 1 Ref.

Descriptors: *Priming, *Condensers, *Diphasic flow, *Nuclear powerplants, Water cooling, Cooling, Pipes, Cost analysis.

The experimental study presented here describes the experiments for visualizing diphasic flow carried out on a 1/10 model of a circulation-water condenser for a 1,300-MW nuclear power unit. The essential object of the experiments was to validate the layout for the tubing proposed by the Design Office, from the point of view of its incidence on the stability of the flows and the mechanical solidity of the structures during the relatively anarchical phase of automatic priming of the con-

denser. The observations made have rendered it possible first to analyze the pattern of flows in greater detail and secondly to conclude that a simplified and cheaper layout of pipes is acceptable without great risk. (Author's abstract)
W84-05042

SUPERCAVITATING THREE-DIMENSIONAL FLOWS. NUMERICAL TREATMENT IN EXACT THEORY. EXPERIMENTS IN A HYDRODYNAMIC TUNNEL. CRITICAL ANALYSIS OF THE RESULTS (ECOULEMENTS TRIDIMENSIONNELS SUPERCAVITANTS: TRAITEMENT NUMERIQUE EN THEORIE EXACTE, EXPERIMENTATION EN TUNNEL HYDRODYNAMIQUE, ANALYSE CRITIQUE DES RESULTATS),
A. R. Laali, and C. Pellone.
La Houille Blanche, Vol. 7/8, p 641-653, 1982. 18 Fig, 2 Tab, 9 Ref.

Descriptors: *Hydrodynamic design, *Cavitation, *Hydraulic machinery, Hydrofoils, Mathematical studies.

The very rapid flows around load-bearing wings (hydrofoils) are of interest because of their use in high-speed marine vehicles, increased use potential for machine parts and the operation of hydraulic components in velocity ranges higher than nominal. An essential difficulty for the correct use of this type of wing is the determination of the free field of cavitation. A series of tests was carried out on a wing of fixed profile whose sweep-back was varied by rotation around an axis at the root, and whose aspect ratio was varied by successive cutting back. The tests were carried out in a hydrodynamic tunnel. Theoretical and experimental results were subjected to critical analysis of the influence of the principal geometric parameters and the area of non-cavitation. When the aspect ratio of a ventilated-base wing is reduced, a study of the slope of the curve, the coefficient of lift in terms of angle of attack, and of the spread of non-cavitation reveals a significant increase in the spread on non-cavitation. This illustrates the advantage of using wings of very low aspect ratio in order to increase the possible incidence deflections of the wing. For swept-back wings, cavitation on the upper surface appears at about 2/3 of the span; on the under surface, cavitation appears first at the wing root. There may be an advantage in using a twisted wing, with a smaller angle for the end sections of the wing than those for the root. (Moore-IVI)
W84-05043

FINITE-ELEMENT CALCULATION OF BLADE-TO-BLADE FLOW IN PUMPS (CALCUL AUX ELEMENTS FINIS DE L'ECOULEMENT AUBE A AUBE DANS LES POMPES),
Florence Univ. (Italy). Ist. di Energetica.
F. Martelli, and G. Manfrida.
La Houille Blanche, Vol. 7/8, p 665-671, 1982. 12 Fig, 1 Tab, 6 Ref.

Descriptors: *Hydraulic machinery, *Turbines, Mathematical studies, Simulation, Flow velocity, Impellers.

Inviscid flow numerical calculations offer a valid tool for the analysis and design of turbomachines. Usually, the coupling of two sets (S1 and S2) of two-dimensional calculation is used to obtain a quasi-three-dimensional simulation of the flow in the turbomachine. The S1 surface calculation is particularly important as it gives important information on the velocity and pressure field inside the bladed channel, and it can lead to a satisfactory calculation of the outlet angle. The proposed numerical analysis is based on the solution of the flow equations on an axisymmetric S1 surface. The analysis is performed directly in the m (meridian abscissa) and theta (angular abscissa) coordinates, using three-node triangular finite elements, after quasi-variational reformulation of the problem. The input is simplified by a generalized use of spline extrapolation techniques, which allow satisfactory discretizations to be obtained starting with a limited set of impeller geometric data. Results of the calculations are presented for two centrifugal runners. (Moore-IVI)
W84-05044

LASER ALIGNMENT TECHNIQUES AT THE WIMBLEBALL RESERVOIR,
D. Wallis.
International Water Power Dam and Construction, Vol. 36, No. 5, p 33-34, May, 1984. 6 Fig.

Descriptors: *Deflection, *Lasers, *Wimbleball Dam, *England, Zone plate alignment, Measuring instruments, Dams.

Zone plate alignment techniques for measuring the deflection of large and small structures have been available for at least ten years. A recent example is the Wimbleball reservoir in Somerset, England, where a laser-based zone plate system, based on an optical level principle, has been installed. Such a system must be capable of detecting deflections with accuracies on the order of 1 mm. The laser is used merely to define a point on the optical reference axis by passing through a reference hole located at one end of the dam. It illuminates a zone plate made up of concentric metal rings, which is equivalent to a long focus lens focussing the hole image on to the measuring target. Its three point system eliminates errors caused by laser misalignment. Misreadings can result, however, from atmospheric turbulence which will affect the image. (Baker-IVI)
W84-05100

HYDROTURBINE VENTING FOR DISCHARGE OXYGENATION,
Tennessee Valley Authority, Norris.
E. D. Harshbarger, S. Vigander, and L. M. Beard.
Journal of Hydraulic Engineering, Vol. 110, No. 5, p 604-613, May, 1984. 11 Fig, 5 Ref.

Descriptors: *Oxygenation, *Turbines, *Hydroturbine venting, Hydroelectric plants, Baffles, Dissolved oxygen.

In the southeastern U.S., hydroturbine discharges from multipurpose storage reservoirs often contain less than the desired levels of dissolved oxygen (DO). These low DO levels usually occur during the summer and autumn and are typically caused by thermal stratification of the reservoir. One method for increasing the DO concentration in hydroturbine discharges is turbine venting, whereby air is aspirated into the turbine draft tube, below atmospheric pressure. Tests were conducted on two existing hydroturbines to evaluate turbine venting as a means of oxygenating discharged water. The hydroturbines were of the vertical Francis type, with a rated capacity of 49 MW at 50 m net head. Additions of baffles to the turbine runner hub and to the draft tube wall were made to generate local suction for aspirating air. The effects of these baffles were evaluated in terms of flow rate of induced air, dissolved oxygen uptake and the effect on unit efficiency and output. Baffles can be used to increase aspirated air and thus dissolved oxygen uptake, but that there is a related loss in turbine efficiency and capacity. (Moore-IVI)
W84-05147

CONTROL OF WATER HAMMER IN WATER SUPPLY SYSTEMS (BEHERRSCHUNG VON DRUCKSTOBEN BEI WASSERVERSORGUNGSSYSTEMEN),
Sulzer Bros. Ltd., Winterthur (Switzerland).
For primary bibliographic entry see Field 8B.
W84-05238

SERVICE INSPECTIONS, OVERHAULS, REPAIRS AND REBUILDS OF HYDROMECHANICAL EQUIPMENT IN HYDROELECTRIC POWER PLANTS (REVISIONEN, REPARATUREN, MODERNISIERUNGEN UND UMBAUTEN VON HYDROMECHANISCHEN AUSRUSTUNGEN IN WASSERKRAFTANLAGEN),
Escher Wyss G.m.b.H., Ravensburg (Germany, F.R.).
F. Schneider.
Wasserwirtschaft, Vol. 73, No. 12, p 489-493, 1983. 7 Fig.

Descriptors: *Hydraulic machinery, *Hydraulic equipment, *Hydraulic turbines, *Hydraulic pumps, Maintenance, Maintenance costs, Economic aspects, Economic efficiency.

Regular service inspections and overhauls of hydraulic turbines and pumps are essential in order to prevent any major damage. Outdated plants should be rebuilt by installing modern equipment. The objective being to improve the economics and reliability of operation, and to ease automation. This will keep the hydrodynamic machinery in a good operation state, maintain its availability, and allow the generation of power from the renewable hydraulic energy source without affecting the environment. (Murphy-IVI)
W84-05265

8D. Soil Mechanics

DYNAMIC RESPONSE AND LIQUIFACTION OF EARTH DAMS,
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
T. A. Mansouri, J. D. Nelson, and E. G. Thompson.
Journal of Geotechnical Engineering, Vol. 109, No. 1, p 89-100, January, 1983. 16 Fig, 1 Tab, 17 Ref.

Descriptors: *Model studies, *Earth dams, *Liquefaction, Wave propagation, Elastic properties, San Fernando Dam, Finite element method, Equations, Interstitial water, Computer models.

A model for predicting the dynamic response and liquefaction of earth structures was developed. The model was based on Biot's theory for the propagation of elastic waves in a porous medium (Biot, M. A., Mechanics of Deformation and Acoustic Propagation in Porous Media, Journal of Applied Physics, Vol. 33, No. 4, p 1482-1498, 1962) and an empirical relation put forth by Finn for the volumetric strain resulting from an applied shear strain (Finn, W. D. L., Seismic Response and Liquefaction of Sands, Journal of the Geotechnical Engineering Division, ASCE, Vol. 102, No. GT8, Aug., 1976, p 841-856). The finite element method was used to solve the equations. The model was applied to a hypothetical earth dam. The model considered the soil as a porous material, saturated with water. Having separate constitutive properties, the soil skeleton and the pore fluid were treated as independent materials. Darcy's law was used to describe the motion of water in the soil skeleton. The results of the analysis were compared to the observed liquefaction in the San Fernando dam and were shown to be reasonable. Finn's equation was used to compute the volumetric strain due to shear strain applied by earthquake loading. By coupling Biot's theory for the propagation of elastic waves in a fluid saturated porous solid with the dilatancy equation it was possible to evaluate the increase in pore-water pressure and thus to predict liquefaction. The model can also be used to compute displacement, velocity, acceleration, effective stress and pore-water pressure. (Baker-IVI)
W84-04810

ANALYSES OF FLOW FAILURES OF MINE TAILINGS DAMS,
Texas A and M Univ., College Station.
J. K. Jeyapalan, J. M. Duncan, and H. B. Seed.
Journal of Geotechnical Engineering, Vol. 109, No. 2, p 150-171, February, 1983. 14 Fig, 3 Tab, 19 Ref.

Descriptors: *Flow, *Mine tailings dam, Dam failure, Dam design, Flow profiles, Flow characteristics, Mathematical models, Computers, Computer programs, Bingham plastic rheological model, Turbulent flow.

A characteristic common to most tailings dam failures is that the mine tailings tend to liquefy and flow over substantial distances, with potential for extensive damage to property and life. In order to be able to assess the potential for damage in case of such failure, it is necessary to be able to predict the characteristics of the flow and the possible extent of flood movement. This paper presents analytical

procedures for making such evaluations. The behavior of tailings materials during flow is represented by a Bingham plastic rheological model in these analyses procedures. It is apparent from the analyses that the flow of phosphate tailings would be expected to be turbulent but flows for other types of tailings would be expected to be laminar. The procedures described are applicable for flow of tailings on horizontal and sloping planes and in prismatic valleys. The analyses can be performed using dimensionless charts in the case of flow on planes, and a computer program in the case of flow in prismatic valleys. (Author's abstract)
W84-04812

INVESTIGATION OF FLOW FAILURES OF TAILINGS DAMS,
Texas A and M Univ., College Station.
J. K. Jeyapalan, J. M. Duncan, and H. B. Seed.
Journal of Geotechnical Engineering, Vol. 109. No. 2, p 172-189, February, 1983. 20 Fig, 4 Tab, 9 Ref.

Descriptors: *Flow, *Main tailing dams, *Dam failure, Dam design, Earth dams, Bingham plastic rheological model, Computer programs, Performance evaluation, Buffalo Creek.

A characteristic common to most mine tailings dam failures is that the tailings tend to liquefy and flow over substantial distances, with potential for extensive damage to property and life. The existence of these potentially hazardous earth structures is of great concern to the public and to the mining industries. In order to be able to assess the potential for damage in case of such a failure, it is necessary to be able to predict the characteristics of the flow and the possible extent of flood movement. A companion paper to this illustrated the various analytical procedures that have been developed for this purpose. The present paper describes a series of flume experiments that were conducted to check the validity of these analysis procedures. In light of the good agreement observed, the results of the analyses are then compared with flow movements observed in several case studies where failures have occurred. (Author's abstract)
W84-04813

FAILURE OF AN EARTH DAM: A CASE STUDY,
Garyounis Univ., Benghazi (Libya).
I. H. Khan.
Journal of Geotechnical Engineering, Vol. 109, No. 2, p 244-259, February, 1983. 12 Fig, 10 Tab, 19 Ref.

Descriptors: *Earth dams, *Dam failure, *Wadi Qattarah dam, Hydrogeology, Soil engineering, Climatology, Soil moisture, Design criteria, Libya.

In the semi-arid zones, seasonal variations in temperature and moisture content are extensive. This may induce severe cracking of the core of an earth dam, particularly in places where the soil is poorly compacted. The winter rains often result in flash floods leading to a rapid build up of reservoir level. Consequently, water flowing through the core has high gradients. Moderately dispersive soils, in such an environment, may become highly dispersive. Such a mechanism of failure has been postulated on the basis of a case study of an earth dam failure in Wadi Qattarah, Libya. Practical implications of this failure mechanism are pointed out in relation to earth dam construction practices in semi-arid zones. (Author's abstract)
W84-04814

ESTIMATING FAILURE PROBABILITIES FOR CALIFORNIA LEVEES,
California Univ., Berkeley.
J. M. Duncan, and W. N. Houston.
Journal of Geotechnical Engineering, Vol. 109, No. 2, p 260-268, February, 1983. 4 Fig, 2 Tab, 2 Ref.

Descriptors: *Levees, *Levee failure, *California, Gumbel distribution, Normal distribution, Probability distribution, Probabilistic process, Peat, Peat soils, Water level.

The probability of failure of California Delta levees was estimated using simple statistical procedures, based heavily on empirical data. Forty-four islands were included in the study, and it was found that the probability of failure was strongly linked to the thickness of peat beneath the levees. When the islands were grouped according to peat thickness, it was found that sufficient historical levee failure data was available to estimate the average probability of failure for all the islands in a given peat thickness group. The relative probabilities of failure for the islands within a group were then estimated using slope stability analysis and simple statistical methods. For each island a Factor of Safety Index (FSI) was computed for ranges in water level outside the levee and a range of values of the strength parameter, phi'. The water level was statistically characterized by the Gumbel Distribution and phi' by a Normal Distribution. The probability that the FSI would fall below some critical value was used to rank the probabilities of failure for islands within a peat thickness group. (Author's abstract)
W84-04815

BREACHING CHARACTERISTICS OF DAM FAILURES,
Leedshill-Herkenhoff, Inc., San Franciso, CA.
For primary bibliographic entry see Field 8A.
W84-05145

PRIMS DAM NEAR NONNWEILER - AN IMPORTANT PROJECT IN THE SAAR REGION (PRIMSTALSPERRE NONNWEILER - EIN NEUER ABSCHNITT IN DER WASSERWIRTSCHAFT DES SAARLANDES),
Landesamt fuer Umweltschutz - Naturschutz und Wasserwirtschaft, Saarbrucken (Germany, F.R.).
H. R. Lorson, H. P. Keitel, and E. Hermann.
Wasserwirtschaft, Vol. 73, No. 4, p 103-108, April, 1983. 7 Fig, 3 Ref.

Descriptors: *Prims Dam, *Nonnweiler, *Saar region, *Earth dam, Performance evaluation, Design criteria, Construction costs, Construction materials, Water resources development.

The Prims dam near Nonnweiler was completed in early 1982. The results of test filling have proven the satisfactory realization of the 62 m high rockfill dam with asphalt sealing. Therefore, operation of the plant, the most important one in the Saar region for water resources, started according to schedule. (Author's abstract)
W84-05236

8E. Rock Mechanics and Geology

MONITORING STRAIN DISTRIBUTION IN THE FOUNDATION ROCK OF LARGE DAMS,
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
K. Kovari, and G. Peter.
International Power and Dam Construction, Vol. 36, No. 5, p 35-38, May, 1984. 6 Fig, 2 Ref.

Descriptors: *Gravity dams, *Strain measurement, *Dam foundations, Dam safety, Load distribution, Albigna Dam, Switzerland.

The complete distribution of strain along boreholes in the rock foundation of large dams provides the best means of understanding the response of the rock mass to changes in load brought about by the fluctuations of the water level in the reservoir. In the case of the Albigna gravity dam, some of the healed joints opened up in the course of time leading to increasing deformation of the dam and to leakage of water. Using sliding micrometer measurements it was possible to recognize clearly these active discontinuities intersecting the boreholes. They made their presence felt by marked peak points in the strain distribution curves. The occurrence of only a few active joints and the high rigidity of the rock mass confirmed the excellent overall rock conditions at the Albigna dam site. Remedial measure to stop the underseepage of the dam were carried out in the summer of 1980. They resulted in a sharp decrease of water loss. (Baker-IVI)
W84-05101

8F. Concrete

STABILITY OF SLURRIES FOR THIN CUTOFFS IN PERCOLATED GRANULAR SOILS (ZUR STABILITAT VON SCHMALWANDSUSPENSIONEN IM DURCHSTROMTEN KORNIGEN UNTERGRUND),
Karlsruhe Univ. (Germany, F.R.).
K. J. Witt, and J. Brauns.
Wasserwirtschaft, Vol. 73, No. 12, p 521-526, 1983. 10 Fig, 7 Ref.

Descriptors: *Cements, *Cement slurries, *Slurries, *Soil properties, Barrages, Concrete mixes, Concrete construction, Concrete technology, Model testing.

Thin cutoffs made of cement-bentonite-slurries are often used for vertical seals, for instance in and underneath the lateral dikes of rivers when barrages are to be constructed in riverbeds. A successful application of such cutoffs may be questionable under the conditions of very coarse grained sediments which sometimes occur in the upper regions of big rivers. The risk of instability and erosion of the fresh slurry-type mix comes up here. The paper describes investigations on the behavior of cutoff mixes regarding their stability and setting behavior. The effect of jellying admixtures is investigated particularly. The problem of stability of fresh mixes in coarse grained soils is demonstrated through model tests. (Author's abstract)
W84-05269

8I. Fisheries Engineering

RESERVE FLOW AND OTHER PRECAUTIONS TO PRESERVE FISH LIFE AT PRESENT IMPOSED FOR MICRO-HYDROELECTRIC POWER STATIONS IN THE AUVERGNE-LIMOUSIN REGION OF FRANCE (DEBIT RESERVE ET AUTRES PRECAUTIONS PISCICOLES ACTUELLEMENT IMPOSEES LORS DE L'INSTALLATION DE MICRO-CENTRALES HYDROELECTRIQUES EN AUVERGNE-LIMOUSIN),
R. Cuinat, and J. J. Demars.
La Houille Blanche, Vol. 1, p 49-58, 1982. 2 Tab.

Descriptors: *Fish guiding, *Micro-hydroelectric power stations, *France, Fish barriers, Fish handling facilities, Fish management, Fish passages, Optimum development plan.

In France, authorization is required from the Prefect's office (department administration level) before a hydroelectric power station of less than 500 kW (since 1980 is 4,500 kW) gross power (micro-power station) can be built. The legislation on this was made many years ago (Law of 1919) and is relatively liberal. Since 1974, as a result of an increasing number of projects carried out in the seven departments of Auvergne and Limousin, and awareness of environmental protection problems, authorization have been generally accompanied by more stringent requirements to be complied with by the construction. Until more accurate technical and scientific data becomes available on the extent to which these dams affect fish breeding, a 'basic legal minimum flow' (BLMF) is prescribed which may range from 70 to 130% of the characteristic rate of flow of the river. This coefficient is proposed by the regional board of the Fishery Office in accordance with quality of aquatic life, accessibility for angling and length of river diverted (generally several hundred meters for every 4 km). The basic minimum flow selected is regulated by a lower value (minimum 0.7 BLMF) during the cold season, a higher value (maximum 1.3 BLMF) during the warm season (April to September), when invertebrate production and trout-growth are at a high level, and electricity requirements are usually lower. Construction of a fishladder and a simple flow control device is almost always required. The authorities usually seek advice from

anglers' associations and the regional board of the Fishery Office (technical department). (Murphy-IVI)
W84-04951

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